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New York Meeting of the American Electrochemical Society.

It has been truly said of the meetings of the American Electrochemical Society that they are always bristling with good-fellowship. If the Society had done nothing but created the esprit de corps which is now so characteristic of the whole electrochemical fraternity, its formation would have been justified. But with every new meeting it becomes more and more manifest that the Society has to fulfill a greater and even more important mission. The remarkable increase in membership during recent months indicates that the Society draws members from all quarters—electrical engineers as well as chemical engineers and metallurgists. The Electrochemical Society acts as a bond between these different interests. For this reason general discussions on subjects of broad interest are greatly to be recommended. There were two at the last meeting. The discussion on the possibility of using electrochemical and electrometallurgical processes for filling out the valleys in the central-station load-curve did not bring any clear-cut results. Nevertheless, the discussion was valuable, as it gave both sides an opportunity to speak their mind freely. If anything is to be accomplished, continuous agitation will be necessary. It is probably true that in the past there has been too much dreaming about possibilities and not enough clear understanding of the other fellow's needs. And as was suggested by one speaker, it may be that to make a success, the two sides must become a unity, i. e., the central station must carry out electrochemical and electrometallurgical processes itself. This would, indeed, be a logical development. If it should be proven that chemical or metallurgical industries can make use of the surplus power of the central station and make a profit, why should the central station not undertake the work itself? The chemical products would then be by-products of the power-generating business of the central station.

* * *

The second general discussion related to the important problem of the corrosion of iron and steel. In spite of its length, the discussion was not and could not be exhaustive, but some important points were brought out clearly and some problems formulated sharply. It seems that in the near future the metallurgy of iron and steel will be one of the principal subjects of practical electrochemical work; and the two important subjects of specifically electrochemical interest are corrosion of iron and steel and manufacture of steel in the electric furnace. It is an excellent proposition to devote a whole day of the next meeting to be held next Spring at Niagara to the electrometallurgy of iron and steel. At the New York meeting the only paper bearing directly on this subject was Mr. FitzGerald's account of the results obtained with the Lash process in the electric furnace at Niagara. One point stands out now more clearly than ever—that a certain process may be carried out as

well in one as in another type of electric furnace. There are essentially two types only. One is for simply melting together ingredients without any chemical refining action. This type is represented by the induction furnace. The other intends to refine steel by removing impurities by chemical reaction between them and the slag. For this purpose a number of different electric furnace constructions is suitable; they all are characterized by the fact that the heat can be easily controlled, that the slag can be heated to any desired temperature, and above all other things, that the reaction is carried out in a neutral or reducing atmosphere. This last point is the essential point which distinguishes the electric steel process from older steel processes. Among other interesting papers presented at the meeting we may call attention to Mr. Hering's valuable paper on heat loss through furnace walls. A full account of the convention will be found elsewhere in this issue.

Fixation of Atmospheric Nitrogen.

The old dream of electrochemists—the fixation of atmospheric nitrogen—seems gradually and slowly to become true. The problem is very simple: the immense quantity of nitrogen in atmospheric air is inert and useless in its elemental form; if forced into the form of a compound—nitric acid or a nitrate—it would be immensely useful for many purposes in peace and war, as a fertilizer and for explosives. The simplicity of the problem, thus stated, is matched by the difficulty of its solution. If we look backwards we find a long series of researches, many attempts and many failures. It is only in recent years that commercial success has been achieved in isolated cases under special conditions. Most attempts have been in the direction of combining directly the nitrogen and the oxygen in the air by means of electric discharges. This was attempted by Bradley and Lovejoy on a large scale at Niagara, but this process proved a commercial failure. Similar in principle (heating to a high temperature by the arc and then suddenly cooling), but using a quite different and much simpler apparatus, is the Birkeland-Eyde process. As repeatedly noticed in our columns this has proven a commercial success in Norway, under most favorable conditions of cheap power (stated to cost $5 or so per horse-power-year). The Notodden plant, which has been working successfully in the past with a capacity of 40,000 kw, is now to be enlarged—the addition reported being not less than 200,000 hp.

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While the Birkeland-Eyde process seems to be an electric-furnace process pure and simple—the arc having no other function but to heat the air to a very high temperature—it appears to be different with the process which is being developed by the Badische Anilin und Soda Fabrik. In their process there seems to be a specific electric effect, as distinguished from the purely thermal effect. They employ an arc in a long tube through which air is passed in a whirling motion. Since 1907 they have operated an experimental plant of 2000 hp and are now planning the erection of a large 120,000-hp plant. Their apparatus is distinguished by greatest simplicity, while the process, if really involving a specific electric besides the thermal effect, would have important advantages over purely thermal processes, as is pointed out in our American Electrochemical Society convention report in this issue in connection with the paper of Professor Morden. Undoubtedly the process having been taken up by the Badische Anilin und Soda Fabrik is in the very best hands, and the recent award of the Liebig medal to the chemical engineer of the Badische Company, Dr. Schoenherr, is well deserved.

* * *

Meanwhile the erection of cyanamide factories is steadily progressing and the most important development in this line is the erection of a very large factory at Niagara Falls. The cyanamide process is not as direct as that of producing nitrogen oxides by electric discharges. The cyanamide process needs first separation of nitrogen from the air, for instance, by liquefying air and fractional distillation; the nitrogen is then combined with calcium carbide at an elevated temperature to form calcium cyanamide ("lime nitrogen") which may be used either directly as a fertilizer or as a starting point for making other chemicals like cyanide. The price which the cyanamide company is reported to pay for power is the lowest ever heard of at Niagara; Mr. Sperry, at the recent Electrochemical Society meeting, claimed it to be somewhat between $10 or $12 per horse-power-year, but certainly less than $12. This would be very low in comparison with Niagara prices of the past but it is still much higher than the cost of some water powers in Norway, for instance. And it is very important to keep strictly in mind that all the processes for the fixation of atmospheric nitrogen can be successful only with cheap power, although the exact figures are known at present only by insiders.

The Drop in the Price of Aluminium.

As was already mentioned in our last issue, the price of aluminium has now dropped to an extent which reminds one of the slump in copper last year. The stage of the aluminium tragedy has been in Europe. In this country the Bradley internal heating patent decision of five years ago, which was against the Aluminum Company of America (at that time named the Pittsburgh Reduction Company), became a blessing in disguise for this company, since after having made arrangements with the owners of the Bradley patent, they were able to maintain their monopoly in this country under the protection of the Bradley patent, after the expiration, in 1906, of the fundamental Hall patents for the electrolyte. The Bradley patent will run out during 1909; until its expiration the Aluminum Company of America is protected as sole producer in this country. The situation has been different in Europe. Stability of production and prices has been maintained there in the past by a firm agreement between the different producers, the so-called international aluminium syndicate, formed in 1901. The objects were to establish distinct spheres of interest and stable prices. For a number of years the syndicate succeeded admirably. But, naturally, as a result of no further protection being obtained by patents in Europe, competition started. Several new works—some quite large ones—were erected by outsiders, and the fight began, with the natural consequences. A great factor in this fight was the decline of the demand for aluminium, especially by the automobile industry, on account of the financial and industrial crisis last year. The last result which we reported in our last issue was the dissolution of the syndicate agreement on Oct. 1, and the final slump in prices began. The price of ingots in London is now between £65 and £75 per ton, which is equivalent to 15 to 17 cents per pound. On

account of the protective duty, the price in this country is about 25 cents per pound. Though in this European war this country has been only an onlooker, the reaction has been distinctly felt here. The monopoly in this country had to yield, since imports from Europe threatened, and 25-cent aluminium means a great change, indeed, from the former steady price above 40 cents.

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It is questionable whether the price will remain as low as it is at present. It seems quite certain that some of the European plants are now forced to sell aluminium below self-cost (if self-cost includes interest on capital, depreciation, etc.). The aluminium industry has always been carried on with greatest secrecy. Nevertheless, the cost of producing aluminium has been estimated to be something like 15 or 16 cents a pound, but the exact meaning of "cost" in these estimates is very doubtful. On the best authority which we have in a special case, the cost, including everything, figured out as only very slightly less than 16 cents per pound in a proposed French mountain plant (which was not erected, but was figured out with greatest care), the cost of electric power being in this case about $8 per hp-year. This was under very favorable conditions of supply of raw materials and electric power. There is no such cheap electric power available for prospective aluminium makers in this country. As a matter of fact, the present situation in the aluminium industry is not very attractive for outsiders to start competition with the present sole producer after the expiration of the Bradley patent in 1909. We may expect fluctuations of the price of aluminium in the near future. The price may finally rise again, but it seems certain that it can never return to the old figures of two years ago. Aluminium appears to have come down for good to a price comparable with copper; there is very little difference now in the London price quotations for copper and aluminium. The net result will be the use of aluminium for many purposes to which it is very well suited, while the former high prices were prohibitive.

The Wear of Iron and Steel.

We have become so accustomed to regarding the great bulk of iron and steel in use as indestructible, except through chemical action, that it is somewhat startling to reflect that certain uses have become so important as to involve the mechanical disintegration and dissipation of an annual tonnage which reaches the dignity of six figures. A line of study is here presented which hitherto has been pursued but little, while prospective changes in materials used make it certain that it is going to receive careful thought in the future. It has been well known, of course, that a large part of the wear of railroad rails, necessitating their replacement, is due to actual disintegration and dissipation of the metal. In a rail worn so as to be unfit for further use there has been a change in the configuration of the head, due to flow of metal, while there has also been a loss of metal. The process of "renewing" rails which have become unfit for service has been more or less in vogue for years and consists in restoring the head of the rail to a proper shape. This process, however, has been treating but a limited tonnage in proportion to the total tonnage of rails annually rendered unfit for further service, and it is recognized by rail experts that a good rail should not be subject to much flow of metal in service, but rather should wear out merely by the dispersion and loss of metal.

This wear is due almost wholly to the rolling friction between wheel and rail. There is wear also of the wheel from this friction, and the quantitative relation between the two is largely a function of the relative hardness, which brings us to a very practical point. Steel wheels are being substituted for the regulation cast-iron wheel, and it is predicted that in course of time the substitution will be complete. It is obvious that the wear of the steel wheel will be altogether different from that of the cast-iron wheel. The steel wheel is made of steel of composition quite comparable to that of rail steel. While the carbon, and consequent hardness, may be a trifle greater than with rail steel, there is a wide gap between the wearing quality and that of the material in the tread of the cast-iron wheel, which is chilled cast iron, and extremely hard. Evidently the loss in weight of the steel wheel, per distance run, will be much greater in the case of the steel wheel than in the case of the cast-iron wheel. The car wheel wears in another way also than by reason of the rolling friction on the rail, on account of the frequent braking necessary to control trains. As between the cast-iron brake shoe and the chilled-iron tread, the wear is presumably almost altogether in the former, but what will be the relation between a cast-iron brake shoe and a steel wheel? Again, will the rolling friction of a steel wheel instead of a chill tread iron wheel on the rail increase or decrease the wear of the rail itself?

* * *

These are very interesting points, and a little indulgence in figures shows that the quantitative solution of the problem involved is of great economic importance, on account of the tonnages involved. Accurate data have not been gathered, but there is sufficient information available to make computations which, while not necessarily accurate, easily prove the magnitude of the tonnages involved. The wear of rails has not been accurately ascertained. Our total production of rails reached 3,977,887 gross tons in 1906, and has averaged fully 3,000,000 tons a year in the past 10 years. These statistics, however, are no guide, as rails are made for export, for mining, logging and other industrial purposes, for trolley lines, for laying new steam railroad track, to replace lighter sections on account of heavier traffic, and to make up for wear. No segregation has been attempted which would show the tonnage normally required for the last-named purpose. The closest approach can probably be made by seeking for statistics of a given operation. The Pennsylvania Railroad system gives annually its statistics of "steel rails used for renewals." The Pennsylvania system has probably progressed farther than any other in attaining a standard weight of rail in its tracks, so that its renewals may be taken as almost wholly due to wear. In the past four years it has averaged 138,085 tons of rails used for renewal, while its average freight-ton mileage has been 31,307,000,000 a year. Dividing the latter by the former, a factor of 226,720 ton-miles of freight per ton of rails worn out is found. Dividing the total freight ton-mileage of the United States in 1907, a record year, by this factor gives 1,028,300, this roughly approximating the number of tons of rails worn out by service in such a year of maximum tonnage. The finding is only roughly approximate, on account of many influences not necessary to discuss. If, now, a rail loses 15 per cent in weight in becoming unfit for further service, there is an actual loss of weight annually

of about 150,000 tons. Doubtless the loss is at any rate in excess of 100,000 tons in a year of full traffic, which material has been costing the railroads $28 a ton, plus freight. There is a still greater loss, in that the remaining weight of the rail has been depreciated from $28 to the price obtainable for old rails, this price having ranged this year within the limits of $12 and $18 a ton. These losses are due to rolling friction. Will the use of hard steel instead of chilled cast iron increase or decrease the loss, and how much?

* * *

The wheel problem itself is still more interesting. Using statistics merely as a rough index to the nature of the problem, it may be cited in the case of freight-car wheels only, that there were at last report (1907) 2,084,214 freight cars in the country, with a total freight ton-mileage movement of 233,137,507,807, which would probably mean about 16,000,000,000 miles traveled by the cars, loaded and empty. Multiplying this by eight, the number of wheels per car, and dividing by 70,000, the usual estimate of the mileage of a wheel which does not break, gives 1,830,000 as the number of freight-car wheels which would wear out in a full year of traffic. As the wheels average about 700 lb. apiece, the weight involved would be about 570,000 gross tons. The loss of metal in wearing out is reputed to be somewhat under 3 per cent, involving 17,000 to 18,000 tons annually. Wear on the rails is caused also by passenger cars and by locomotives and tenders. Passenger car-mileage is only about one-eighth of freight car mileage, so that over half the rail wear is doubtless due to the passage of freight cars, say, not far from 75,000 tons of rail steel worn off, against 15,000 or 17,000 tons of material worn off freight car wheels by the action of the rolling friction and the braking. Although expert testimony is lacking, it seems safe to assume that the great bulk of this wear is due to the braking, so that in the rolling friction nearly all the loss of metal is by the rail, very little being lost by the wheel.

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What will be the wear of the steel wheel itself, and will the wear of the rail be altered by the change from the chilled cast-iron wheel to the steel wheel? There is some ground for presumption that the steel wheel will wear, from the rolling friction, almost as much as the rail, and if so, the loss of metal by the steel wheel will be much larger than the loss by the iron wheel. It will be a serious matter if it reaches 150,000 tons a year. For the steel wheel a much longer life is expected than is realized with the chilled cast-iron wheel, but that does not necessarily mean less loss of steel. The iron wheel wears very rapidly once the hardest part of the chill has worn off, whereas with the steel wheel the wear could easily reach a considerable depth. Some tests by the Pennsylvania, we understand, have promised a life for a steel wheel three times the usual life of an iron wheel, but doubtless the loss of metal would be much greater than with the iron wheel, as we have the testimony of an expert that the average cast-iron wheel, weighing when new, say, 700 lb., loses only about 25 lb of metal in service. Problems involving the dispersion and absolute loss of hundreds of thousands of tons of metal annually, and the rendering unfit for service of many times that tonnage of rails or wheels, will doubtless receive the careful attention of the experts in the field.

The Increase of Gold Production and the Increased Cost of Living.

Everyone is familiar—most people unpleasantly familiar—with the constantly growing cost of living in the past 10 years. Careful inspection of household accounts would place this increase at between 40 and 50 per cent, probably nearer the higher figure. The alleged causes of this are numerous—labor troubles, the increased national expenditures, general personal extravagance, the formation of "trusts" and monopolies, and so forth. These are really mostly only symptoms. One of the fundamental causes is undoubtedly the increase in the production of gold, although there are other contributing causes. In turn, the increase in the production of gold has been caused by the application of modern science to gold mining and metallurgy, resulting in important progress in the cyanide process, high explosives, the power-drill, and electrical transmission of power. In general, all industry and all our social life has been profoundly affected by the expansion of applied science. Both of these tenets, the minor as well as the major, have been often referred to in our editorial columns. In the lay journals, also, the same question is now receiving attention. Lately various expositions of the effect of "gold depreciation on prices and values" have been given by different writers in the popular magazines.

* * *

The official facts are that the world's production of what the journalists style, "the yellow metal," was, in round numbers, as follows: In 1884, 102 millions of dollars; in 1896, 202 millions of dollars; in 1907, 413 millions of dollars. At present, gold production, which was restricted in 1907 (only increasing a little over 1 per cent) by the increase in cost of labor and supplies, and also by the actual physical difficulties in procuring these, is now increasing more rapidly than ever and piling up so fast that the reserves of gold in Paris, New York, London, and Berlin are enormous, and the interest rates are now at the lowest figures in recent years. The natural inference from this is that since the interest rates had, early in 1907, risen so rapidly all over the world that the margin between interest paid by the "entrepreneur" and the profit arising from his usufruct of capital had been cut so low that the restriction in business was logical and, in fact, inevitable. For, of course, when business conditions were such that the business man could not make enough to pay the interest asked for money borrowed, the volume of business must recede. The converse of this is that when interest rates are so low that there is a wide margin or "difference of commercial potential" between what the capitalist asks for the use of his capital and what the business man can make out of this capital when lent him, that then the volume of business will increase. As in any system, be it electrical, physical or economic, there is a "lag" between "the impressed force" and the "flow of current," so the lag in the system under consideration is caused by the "commercial inertia." Just as in an electrical circuit, there is a measurable moment of time between the closing of the switch "putting 110 volts on the line" and the resultant flow of 110 amp through a resistance of 1 ohm, so is there an interval from the time when the "commercial voltage" is applied (represented by the marginal difference of 3 per cent between the average rate of in-

terest, say, 4 per cent asked, and the productivity of capital, say, 7 per cent), until the volume of business increases. The "lag" in the case of the electrical circuits is due to "self-induction," which may be illustrated by the model that the many little magnetic circuits or "idle wheels," as one physicist calls them, must be started, turning each other successively. So, also, the wheels of business of the many interdependent business circuits of "producer-consumer," "consumer-producer"—for each working individual produces or helps to produce one class of commodities and consumes those produced by other people—must slowly start each other in motion. This analogy between business and electricity is, as analogies go, a fairly close one.

* * *

With this country and Germany as leaders in this development, the world has had in the past seven years a prolonged period of inflation and expansion, followed by social and political unrest, increased cost of living and high interest rates. One writer makes the statement, with the vertigo of the prophet, that "our present troubles may be multiplied several times before the end of the next decade." This we believe to be a rather extravagant statement. To everything there is an opposing force. And against this can be said that in 1907 there was a perceptible check to the increase in the production of gold, due to labor troubles and enhanced cost of labor and decreased efficiency of labor. This was felt everywhere, in the Rand, in Colorado, in Nevada, and in Alaska. It was a real condition and not a theory. There are many good gold mines that because of this have not been paying propositions, if the depreciation of the mine due to the exhausting of its ore-body be reckoned. Next, other nations will find it profitable to change from a silver basis to a gold basis, and this will increase greatly the need for gold. Finally, the volume of the world business has been in the past so expanded that it needs a greater supply of gold for the increased volume of trading. This is an age of metals, and let us consider two metals most necessary for modern civilized life, namely, iron and copper. These metals resemble gold in one respect, that a large proportion of their production is not annihilated when passing into the consumer's hand, but form a permanent supply that returns to the market sooner or later in the form of "scrap." Taking the seven years of expansion from 1900 to 1906, inclusive, which are the fairest test years, we find as follows: The gold production increased from 1900 to 1906 from $260,700,000 to $407,700,100, or 147 millions, an increase of 56.5 per cent; copper production increased from 526,000 short tons in 1900 to 790,000 short tons in 1906, or 266,000 short tons, an increase of 48.4 per cent; pig iron increased from 28,700,000 long tons in 1900 to 49,900,000 long tons in 1906, or an increase of 73.9 per cent. Now, as the prices of these metals increased about 50 per cent in that period, we see that their aggregate value measured in terms of gold, increased much more than the increase in the money to buy them. This tendency of things to compensate each other shows that the effect of gold increase was to stimulate production of all things by an increase in price until both price and production outran the ability of the world to purchase things.

* * *

There is one other factor of great importance in effecting inflation. In examining into the past for the sake of learning about the future, we see very clearly that the amount of "destructive consumption" was a cause of the period of inflation starting with 1899 and ending 1907. For, beginning with 1898, we had for eight years a series of events which caused the destruction of much capital and diminished by just such an amount the capital available for the constructive enterprises that modern civilization so sorely needs. These were our own little Spanish and Philippine imbroglios, the great Anglo-Boer war, which caused such a strain on the "rich man of the world," England, the Russo-Japanese war, the San Francisco and Valparaiso earthquakes. The amount of destruction that these did was incalculable and their action was successive. Accordingly, they had a series of stimulating effects on business, as they made successive demands for the increased production of all commodities. Such a period of inflation was seen in 1867-72, and the long period of depression following this period was the reaction from the artificial stimulus by the destructive consumption of our civil war. The amount of much future "destructive consumption" cannot, of course, be foretold, for it is in its nature entirely fortuitous. Undoubtedly its influence on future inflation will be strong, and without wars or other calamities, our industry should have a more normal growth, although unfortunately we can surely count on much by the waste and extravagance of most of the American people, rich and poor alike. But even without the artificial stimulus of wars and earthquakes, the increase of gold production will act seductively by making the speculative part of the public rich, and some of the people think they are richer than they really are.

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Such a discussion, if continued, would lead to more difficult questions of finance. But, in brief, it can be stated that gold production will increase in the future, but at varying rates of growth. The maximum will be reached shortly after periods of depression when the one commodity for which there is a certain market is gold and the cost of producing an ounce of gold in labor and supplies will be lessened because the supply of these is greater than the demand of post-panic times. At this time interest rates will fall to a minimum. The minimum of increase of gold production will follow a period of inflation when consumption of base metals and commodities is at a maximum, and the prices of these have arrived at a maximum, to such an extent that the volume of trade can only be extended beyond the limits of safe banking. At this time interest rates will rise to a maximum. Finally, a crash will come because the financially wise will have started to call in their loans if lenders, or not to make loans if borrowers, because the margin between rates of interest and productivity of capital is approaching zero as a limit. This is the cycle of prosperity and depression as indicated by the course of gold production and as affected by it. It is to be supposed that with the greater diffusion of intelligence and better facilities for transmission of information, as the ocean cables, telegraph and telephone, these industrial cycles will be shorter in period and less violent. This expectancy would be logical, but that socialistic agitation from the "many that have not, yet want" will tend to increase the severity of industrial depressions. And, after all, human nature is more or less immutable.

American Mining Congress.

The eleventh annual session of the American Mining Congress will be held in Pittsburgh, Pa., on Dec. 2, 3, 4 and 5.

"The American Mining Congress is a voluntary association of mining men, devoted to the up-building of the mining industry. In years past it has been largely devoted to the precious-metal mining interests, but the appalling and unnecessary loss of life in coal-mining operations has induced it to make an active effort looking to the adoption of such legislation as will furnish greater safeguards to the working miner.

"Congress, at its last session, appropriated $150,000 to be used in investigations looking to the better protection of lives of miners. The success of this work was made possible by the active co-operation of the coal mining interests and indicated the apparent necessity of uniting every branch of the mining industry into an organization which would urge legislation of general benefit. The further efforts for the final enactment of House Bill 20,883, creating a Federal Bureau of Mines, and the securing of proper appropriations for its effective work, should receive the active co-operation of mining men everywhere."

Mr. J. H. Richards is the president. Mr. J. F. Callbreath, Jr., care Chamber of Commerce, Pittsburgh, Pa., is the secretary.

American Institute of Chemical Engineers.

A meeting of the American Institute of Chemical Engineers is to be held in Pittsburg, December 28th and 29th, in the buildings of the Carnegie Technical Schools.

Papers of general chemical engineering interest are to be presented. Notable among these will be a paper of Mr. James Gayley, vice-president of the U. S. Steel Corporation, regarding his now celebrated process for dehydrating air, for the blast for blast furnaces, and for converters. Other papers on the use of fuels and the production of power are to be presented. "The measurement of high temperatures" and "dryer calculations and dryer designs" are the subjects of two other important papers.

One interesting feature of the Pittsburg meeting will be the exhibition by manufacturers of novel plants and machinery, partly by drawing and partly by the actual installation for tests in the presence of the Institute. These exhibitions and tests are in no way official in that the Institute does not undertake to pass official judgment upon any of the exhibits, and are no more sanctioned or indorsed by the Institute than technical papers presented to it would be, but are offered by the manufacturers as a method of acquainting those in charge of manufacturing operations with the latest and best machinery in the various lines.

Such an exhibit, however, should be an increasing source of breadth and education to the members, and the tests and discussions which will inevitably result from the special installation of machinery for this purpose should do much to unify the judgment of chemical engineers on the question of certain classes of apparatus which have hitherto been largely matters of individual opinions.

This meeting will be the first annual meeting of the American Institute of Chemical Engineers, organized last spring in Philadelphia for the purpose of bringing together all those who are particularly interested in the combined application of chemistry and engineering to technical problems. An account of the proceedings of this inaugural meeting was given on page 272 of our July issue.

The organizers of the Institute, after considerable investigation as to the need of such a society, have made the qualifications for active membership extremely rigid, believing that a very important object of an organization of chemists or engineers (besides meeting for purely social purposes) should be the raising of the professional standard among its members. To this end a careful and serious effort is being made to so limit membership that admission to the Institute will be in itself an evidence of the standing and reliability (both business and professional) of its members.

That there was need for some such movement is sufficiently evident by the extent to which fake processes have at times been offered in this particular field. Hitherto chemistry has, by the very nature of the phenomena studied, the transformation of matter, presented that element of the mysterious which seems to be important to the successful exploitation of fraud. Numerous patents, which never worked and never could work, have been taken out and sold or made the basis of "wildcat companies." Numerous manufacturers have been victimized and it is hoped that in time the Institute of Chemical Engineers may be able to do for the chemical engineering profession what the Society of Civil Engineers has so ably accomplished in its field.

All communications from those desiring to attend the Pittsburg meeting, or from manufacturers who desire to exhibit, should be addressed to the secretary, Dr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

American Electrochemical Society.

The annual meeting next spring will be held at Niagara Falls, Canada, on May 6, 7 and 8; the headquarters and place of meeting will be the Clifton House on the Canadian side.

President Acheson and the other Niagara Falls members of the Society have expressed their intention to make this meeting a record-breaking one as far as that is in their power. One day of the meeting will be devoted to a symposium on the electrometallurgy of iron and steel.

The increase of membership of the American Electrochemical Society has been most gratifying during the last few months. After 61 gentlemen, the names of whom were given in a recent issue, were elected members at the September meeting of the Board of Directors, 29 more members were elected at the October meeting.

The Iron and Steel Market.

There has been no change in the month in the general demand for finished steel products. In the second half of October a fairly heavy buying movement in pig iron started, and this continued for a short distance into November. A general advance in pig iron prices then took place following, chronologically, the buying movement, the election and the improvement in sentiment, but just what relation of cause and effect there was is not so easy to determine.

Last June marked a low point in demand for iron and steel products. Since then there has been a more or less irregular increase in demand. The increase has been at a less rapid rate in the later than in the earlier part of this period. The present outlook is that the demand, in point of tonnage, is likely to be less in the next three months than it has been of late. This does not reflect any less strength in the general market situation; it reflects rather the season, which is naturally one of light operation in many products, particularly the heavy tonnage lines such as rails, plates and shapes. Since last October the steel industry has been operating at much less than full capacity; for about three years previous it had operated substantially at full capacity. Then buyers had to take deliveries of material when they could get them and there was no slackening off in total tonnage in the winter months. Now, on the other hand, deliveries are subject to the convenience of the buyer.

Prices for steel products are more firmly held than for several months. In late September and early October there was a little shading in tin plates, but this quickly disappeared, and the market has since been firm. In black and galvanized sheets there was shading for months, but about the middle of Novem-

ber the market became firm through the determination of individual manufacturers that no advantage was to be gained by shading. In plates the shading has decreased.

Early in the month the rail mills reaffirmed existing rail prices for 1909 delivery, as was to have been expected. The Atlantic Coast Line placed an order for 25,000 tons; otherwise little has been done in rails. The railroads are not placing orders as early as usual, partly because they have no doubt that any desired deliveries can be secured with orders placed later and partly because they are not sure what their financial resources will permit them to do. This year's rail production will probably fall below 2,000,000 tons, against between 3,600,000 and 4,000,000 tons in each of the past two years. Demand will be larger for next year, as rails are wearing out, but it is the fact that much less than half the production in the past few years has been for the purpose of replacing rails merely because they were worn out.

Chairman Gary, of the United States Steel Corporation, has issued cards for another dinner to the iron and steel interests, Dec. 10, in New York. No matter of importance is to be discussed, while there will doubtless be much felicitation on the favorable outcome of the national election.

Pig Iron.

Following the general buying movement in the last fortnight of October, which was particularly heavy in New England and other Eastern districts, there was a fairly active market in early November, partly the closing of negotiations undertaken in October, but involving also heavy buying of basic pig in the East up to the middle of the month, and fairly heavy buying from furnaces along the lake front. Prices were pretty generally advanced toward the close of the movement, the advances being most conspicuous in the case of Mahoning and Shenango Valley furnaces, the advance in which district was quite out of line with actual conditions and seems to have been prompted almost wholly by sentimental considerations. While a large tonnage of pig iron has been bought, in the aggregate, it is important to note that deliveries extend over a long period and do not foreshadow any material increase in the daily rate of consumption. The buying seems to have been prompted almost wholly by a belief on the part of consumers that prices had got as low as they were likely to get, and might undergo some advance. There has been a rather large increase in production by merchant furnaces, and there is reason to believe that the increase in production has exceeded any increase, realized or in prospect, in the consumption. The output of steel works furnaces has been regulated more closely to the actual requirements.

Present asking prices of valley furnaces represent a rather wide range. A few furnaces appear willing to do $15.50, furnace, or $16.40, delivered Pittsburgh, on No. 2 foundry for first quarter delivery; others have a minimum of $16, and others quote still higher. On basic iron prices range from $15.50 to $16, while on Bessemer there are a few sellers at about $16, the largest producer quoting $17. The low points, made in October, were $14.35 for No. 2 foundry, $13.85 for basic and $14.45 for Bessemer. These prices were close to cost, in the case of a furnace buying its ore in the open market, and the question then was whether the market would remain in such relation, or would decline below that cost level, but leaving a profit to those furnace interests having their own ore supplies. Present asking prices involve an excellent profit, as, roughly speaking, a profit of a dollar a ton will pay for such furnaces as these in the course of from three to five years' production. The advance in the valleys had a direct effect on the Chicago market, withdrawing competition and allowing Chicago district furnaces to advance prices to a basis of $17, Chicago, for No. 2 foundry. Eastern Pennsylvania furnaces have advanced prices slightly, to $17 to $17.50, delivered, for No. 2X foundry. The South is firm at $13, Birmingham, for any delivery, an advance of 50 cents.

Billets and Sheet Bars.

The market has been very quiet in rolling billets, but there has been a decided improvement in demand for forging billets, especially in the West. Sheet bar requirements are heavier. Prices remain at $25, Pittsburgh, for rolling billets; $27 for forging billets and $27.50 for sheet bars, half the freight from Pittsburgh being conceded when the rate lies between $1 and $3.

Finished Material.

As noted, the concessions on certain lines have almost entirely disappeared. There is not a great deal of new buying, but with some new buying and with specifications on old contracts the volume of finished steel business coming to the mills is about up to the average of the past two or three months. Tin plates have taken on more activity, being bought with confidence for first quarter delivery, the chief activity being in plates for the salmon packing trade.

Prices are substantially firm, as follows, except that light rails are sometimes shaded about $2 a ton. Prices are f.o.b., Pittsburgh, except in the case of standard rails, which are f.o.b. mill.

Standard rails, $28 for Bessemer, $30 for open-hearth.

Light rails, $25.

Plates, 1.60 cents for tank quality.

Shapes, 1.60 cents for beams and channels, 15-in. and under, angles and zees.

Steel bars, 1.40 cents; iron bars, 1.50 cents, delivered Pittsburg; 1.42 cents f.o.b. Pittsburg for western delivery.

Plain wire, 1.80 cents; wire nails, $1.95.

Sheets, 2.45 cents, net, for black; 3.50 cents, net, for galvanized, 28 gage.

Tin plates, $3.65, net, for 100-lb. cokes.

Convention of the American Peat Society.

From an educational standpoint as well as an impulse for further advancement in peat utilization the Toledo meeting of the American Peat Society, on Oct. 22, 23 and 24, 1908, was a decided success.

Among the leaders in this new movement, to create a peat industry, are Prof. Charles A. Davis, author of the standard work on peat, chief in charge of peat investigation for the United States Geological Survey; Prof. R. K. Fernald, engineer in charge of gas producers, United States Geological Survey; Dr. Joseph Hyde Pratt, State geologist of North Carolina; Erik Nystrom, of the Bureau of Mines, Ottawa, Can., author of "Peat and Lignite," indispensable as a reference book on peat; Dr. Otto Zwingenberger; Robert Schoor, of San Francisco; Prof. Richter, of the University of Wisconsin, together with such serious and energetic field workers as Carl Kleinstueck, Dr. J. McWilliam, F. J. Bulask, Ernest V. Moore, the Milne Brothers, E. C. McKenny, Otis E. Moulton and many others.

In the absence of the president, Dr. J. H. Pratt, Prof. Charles A. Davis, of Ann Arbor, Mich., called the meeting to order on Thursday, Oct. 22. After a few preliminary remarks he introduced Mayor Brand Whitlock, of Toledo, who welcomed the delegates. Mr. Otis E. Moulton, of New Hampshire, then reported for the New England States. He gave a vivid description of various attempts made in Maine, New Hampshire and Massachusetts, and is convinced that quite a peat industry will spring up there during the next season.

Mr. Carl Kleinstueck, of Kalamazoo, Mich., reported for the Northwestern States. He had received numerous inquiries, and visited Mason City, Iowa, where he was called upon to pass judgment upon some excellent peat bogs found there. The outcome was the establishment of a plant at Fertile, Iowa, successfully operating all summer. His own plant was working at its full capacity, and he could have sold three times as much as he produced at $5 per ton.

Mr. Erik Nystrom, of the Canadian Bureau of Mines, gave a brief report, stating that he only knew of two places where they are actually making peat-fuel in Canada. Many companies

have been formed, but nothing further has been heard from them. The government has been interested in the matter of peat development, and some surveys of different peat bogs have been made by the Bureau of Mines, which will establish a peat gas and power plant for experimental purposes during the coming year.

Dr. J. McWilliam, vice-president for Canada, then reported on the work done in the Canadian district, emphasizing the development of a process for making peat briquettes, and his experiments in using peat dust for fuel under boilers, which he had successfully accomplished with peat dried to 5 per cent of moisture.

Mr. F. J. Bulask, of Toledo, spoke on the work in the vicinity of Toledo. His peat-fuel plant has been hampered in its development because of lack of transportation facilities; but the delay has given time for experimental work in various directions. He emphasized the great need for a practical dryer for artificially drying peat fuel.

The election of officers resulted in Dr. J. H. Pratt being elected president. Prof. Charles A. Davis is editor-in-chief of the journal of the society.

The committee on resolutions and by-laws, consisting of Dr. McWilliam, of Canada, Mr. C. M. Crouse, of Syracuse, and Mr. C. T. Pennock, of Chittenango, N. Y., recommended that the membership fee in the future should be $3 per annum, which entitles to all publications of the society, and that associate membership at $2 per annum be discontinued. This motion was carried.

The papers read at the meeting, and which will be published in full in the *Journal of the American Peat Society*, were as follows:

"Commercial Aspect of Gasifying Peat," by Robert Schorr, engineer, San Francisco.

"Utilization of Peat," by Dr. Samuel S. Jodidi, Agricultural Experiment Station, East Lansing, Mich.

"Peat and Swamp Land," by Joseph Hyde Pratt, president American Peat Society.

"Life in a Michigan Peat Marsh," by Carl Kleinstueck, Kalamazoo, Mich.

"Peat in Ireland," by Herbert Garnett, Eaton Rapids, Mich.

"Briquetting of Peat," by Otis E. Moulton, Dover, N. H.

"Latest Developments in Peat Gas Producers," by Dr. Otto Zwingenberger, New York.

"Peat in Indiana," by A. E. Taylor, Findlay, Ohio.

"Artificial Wood Made From Peat," by F. Schuenemann, St. Louis, Mo.

"Latest Peat Researches of the United States Geological Survey," by Prof. Charles A. Davis, Ann Arbor, Mich.

All the papers were listened to with profound interest and interesting discussions took place, especially on peat drying, peat gas and the recovery of nitrogen for fertilizer. The majority of papers were on peat gasifying, and as both the United States Geological Survey at the Fuel Testing Plant, at Pittsburgh, Pa., and the Bureau of Mines, at Ottawa, Can., will install peat power gas plants, it is anticipated that in the New England States, in Michigan, Illinois and Western New York peat producer-gas plants will soon be erected. Prof. R. K. Fernald, engineer in charge of Gas Producer Division, United States Geological Survey fuel testing plant, gave a vivid description of a Swedish producer, successfully operated for two years, and Erik Nystrom, of the Bureau of Mines, Ottawa, Can., spoke of the Koerting gas-producer plant now in erection.

The Commercial Artificial Fuel Company extended an invitation to a dinner at the Hotel Secor on Friday night, which was greatly enjoyed, and on Saturday the same company invited the guests to inspect their plant, 18 miles from Toledo. A full description of the workings of the plant will later be published in the *Journal*. The next meeting will be held in September, 1909, in Boston. Applications for membership are to be sent to the secretary-treasurer, Mr. Julius Bordollo, Kingsbridge, New York City.

CORRESPONDENCE.

The Origins of Hot Galvanizing.

To the Editor of Electrochemical and Metallurgical Industry:

Sir: It is generally understood that Craufurd's patent of 1839 marks the advent of Hot Galvanizing. This statement is copied from one article to another, but I have had the curiosity to look further back in the annals of science, as it seems inconceivable to me that earlier metallurgists should not have attempted the operation for commercial purposes.

The earliest record I have found is that of a certain Dr. Malouin whose researches were presented before the Academy of France in the years 1742 and following; his early experiments were made in 1741. Dr. Malouin published the fact that iron could be whitened by immersing in a bath of molten zinc, as in the case of tin. He claimed greater durability than in the case of tin-plate, and resistance to melting of the surface under great heat. We know that the greater durability is due to the direction of the electrolytic current set up by the metals in contact, and that galvanizing cannot be as readily sweated off iron as tin, because it is hardened and its melting point is considerably raised by absorption of iron.

In 1742 Jean Baptiste Kemerlin proposed various baths containing zinc for use on domestic utensils. Hot tinning had been introduced on a large scale long before this for coating copper and even iron plates and dishes which took the place of the solid tin ones, these being too expensive for the poorer classes to use. It was not, however, until the year 1778 that Monsieur de la Folie of Rouen suggested that instead of tinned copper, zinced iron be used for plates and similar articles. The deleterious effects of the zinc salts generated by the action of acids does not seem to have been known at that time, but it was noticed that the zinc was more readily attacked by various agencies when spread over iron than when by itself; this is due, as we know, to the electrolytic action which hastens the formation of zinc carbonate in the presence of moisture. In an extensive discussion of galvanized articles for domestic purposes which is found in the Annales de Chimie for the year XII (1803) vol. 51, page 49, the deleterious effects of zinc salts were thoroughly discussed and zinc finally condemned for the purpose.

One of the greatest drawbacks of galvanizing had been the difficulty of getting zinc to adhere properly to the articles coated. Resin, which was used in a powdered form as a tin-plating flux, had been tried for zincing also, but in the year 1802 Buschaendorf, of Leipsick, proposed (See Journal des Arts et Manufactures for that year) sal-ammoniac to be used in place of the "colofane," or resin. He also suggested as the best method to follow in the case of copper articles, a first bath of tin and a second one containing two parts of tin to three of zinc.

Thus it is evident that galvanizing by means of a zinc bath, using sal-ammoniac as a flux, was known a considerable time before the appearance of the Craufurd patent.

Pittsburg, Pa. Alfred Sang.

The Inventor of the Tungsten Lamp.

To the Editor of Electrochemical and Metallurgical Industry:

Sir:—A great deal has been written and said about the tungsten filament and the Germans have received the credit of being its inventors. This, however, is not the case, although we must give them credit for its development. It has not been generally known that a young American, while still in his teens, was the inventor: Mr. Turner D. Bottome, who, by the way, was an exceedingly bright electrochemist and contributed a number of electrochemical inventions to the world. The writer was fortunate in knowing Mr. Bottome personally, assisting him in

some of his work and subsequently succeeding him, after he left the laboratory of Mr. Tibbits, through failure of health.

In the early part of the year 1887, Mr. Bottome, scarcely eighteen years old, became associated with a lamp company in Harrison, N. J., called the Vitrite Aluminoid Lamp Co. Being a great student and observing the defects of the filament, made by the company with which he was connected, he conceived the idea that the metal tungsten had properties of peculiar advantage for an incandescent-lamp filament, a metal of fairly high resistance, and of very high fusing point. During the process of the invention some men made strong efforts to get the invention away from him, and Mr. Bottome would have lost it but through the effort of the late John B. Tibbits, of Hoosick, N. Y.

Mr. Bottome told the writer the whole story and said that Mr. Tibbits came to his aid and after the patent was allowed he was paid a handsome sum for it. Mr. Bottome's application was filed September 29, 1887, and allowed April 9, 1889; it is No. 401,120. He also took out a patent for treating the filament, dated August 6, 1889, No. 408,286. Another patent of his relates to a molybdenum filament; the date of this I have not just at hand, but it was about the same time.

Mr. John B. Tibbits, who took up this young man, was an Episcopal clergyman of considerable means, and a man of very bright ideas and quite an inventor himself. He spent a large sum of money on electrical research work. This appeared to be a hobby of his, and he took great comfort in his work. Some of his suggestions were thought visionary at the time, but some of them have since proven perfectly feasible.

In conclusion I would say that the credit of the invention of the tungsten lamp belongs to Turner D. Bottome, an American, and its birthplace is Harrison, N. J., the town of the largest lamp factory in the world.

SOUTH ORANGE, N. J. JNO. A. YUNCK.

The Electric Furnace for Rail and Ordnance Steel.

To the Editor of Electrochemical and Metallurgical Industry:

SIR:—I have read with great interest Mr. Walter Rosenhain's paper on "The Study of Breakages," at the meeting of the British Association in Dublin, as published in your November issue, page 459. The subject involved is a very interesting one, as it covers a large variety of steel products, like rails, gun tubes and other ordnance materials, railway axles and tires, boiler plates, boiler tubes, steel forgings and castings of every description.

The sudden breakage of any of such products, while in service, is often accompanied by serious losses of life and limb and great loss of property.

I will only quote from Mr. Rosenhain's paper briefly such as comes within the scope of what I desire to say on the subject:

"According to the stage at which the defect which has resulted in breakage has arisen, the causes of failure may be classed into three large groups:

"Group 1.—Defects arising from the manufacture of the material of construction.

"Group 2.—Defects arising from incorrect treatment of the material during the process of construction.

"Group 3.—Defects arising during the life of the structure or machine."

The defects due to Group 1 and the defects and resulting accidents due to Group 3 are beyond any doubt the most frequent.

Ever since the railroads have found ways and means to definitely determine the causes of rail breakages, it has been proven that many of them were due to the presence of foreign, injurious bodies, such as slag, manganese sulphides, etc.

Later on it is stated:

"The paper concludes with four typical examples of failures with details of their investigation. The first, one of the inner tubes of a large gun, which developed internal cracks and ultimately fissured completely after an abnormally short life. Tensile tests, alternating stress tests, and impact tests were made, as also detailed micrographic examinations, and the following summarized general conclusions deduced:

"The microscopic evidence, when correlated with the results of the mechanical tests, leads to the conclusion that as regards general composition, heat treatment and mechanical treatment, the steel of the fractured gun-tube is normal, but that its strength is perceptibly impaired by the presence in its mass of a very large number of slag enclosures. The presence of these foreign bodies particularly reduces the power of the steel to resist cracking transversely to the direction of forging, and the presence of longitudinal cracks in the tube is in accordance with this view."

At the meeting of the American Society for Testing Materials, at Atlantic City, held last June, Dr. Henry Fay, of the Massachusetts Institute of Technology, read an elaborate paper on "A Microscopic Investigation of Broken Steel Rails: Manganese Sulphide as a Source of Danger."

"The first piece examined was a small section broken out of the foot of a rail and having a good-sized check. The metal was cut through just beyond the check and polished to a mirror surface. The surface was pitted badly on a line with the check, and under the microscope manganese sulphide was shown where the pitting had taken place. The appearance of pitting from slag is usually quite different. Examinations were then made of a number of rails which had broken in the foot in the crescent form. Near the top surface of the fractured piece the metal in nearly every case showed a thin layer of more brittle material, and in many cases fine checks extending in the direction of rolling. In each polished specimen manganese sulphide was found in considerable quantities, either alone or accompanied by ferrite. Tests were made demonstrating the brittleness of the manganese sulphide, also that it was cemented but weakly to the steel in which it was embedded. Other fractures besides crescent breaks were also found to be connected with manganese sulphide. The form in which the sulphide exists determines whether it is harmful. If the metal has been forged the sulphide will appear in small spherical masses. If there has been rolling, begun at high temperatures, the sulphide areas will be elongated, as in the crescent breaks.

"Le Chatelier has stated that as sulphide of manganese often appears crystallized it has a higher freezing point than any other of the constituents. This has been granted by some experimenters and questioned by others. The author detailed an experiment by which he had determined the freezing point of manganese sulphide to be 1162°, refuting Le Chatelier's claim, and explaining the elongated masses of the sulphide. If rolling begins at any temperature above 1162°, the manganese sulphide will still be liquid from the temperature at which rolling began down to 1162°., and below this temperature being in a plastic condition it is elongated in the direction of rolling. It appears in elongated threads where rolling pressure is exerted on three sides."

Dr. Fay finally winds up as follows:

"Specifications should be so drawn as to limit the amount of sulphur in the steel. Then the metal should be allowed to stand longer after the ferro-manganese addition. With specific gravity of manganese sulphide 3.966 and of steel 6.82, the former should rise to the surface and be skimmed off with the slag if given sufficient time. Usually the interval between the ferro addition and pouring is very short. But if a low-sulphur ore is not available to start with, or if a sufficient time cannot be given for the removal of manganese sulphide, *a resort must be had to electric refining* of the molten metal by means of a basic slag."

All the foregoing practically confirms the many reports made from thorough investigations of broken rails, both here and abroad, due to the same causes.

At the same meeting Col. E. D. Meier, Chairman of Com-

mittee R, urged for a purer, stronger and more uniform material for boiler plates.

It is stated that steel under 0.03 sulphur is hard to secure in view of the difficulties the steel makers are encountering with the raw materials and fuel obtainable.

People who are thoroughly familiar with prevailing conditions know very well that Dr. Henry Fay's call for purer ore and more time for removal of manganese sulphide and the demand of resting the hot metal sufficiently long after melting, to allow all the slag and other undesirable elements to rise to the surface and to be skimmed off, is in vain.

Such pure ores as he has in his mind are nowadays not obtainable in sufficiently large quantities to satisfy the enormous demands required for the large tonnage products, and the price of such high-grade ore would be prohibitive. At any rate, it is not to be obtained in any such quantities at any price.

Furthermore, our modern methods of producing an enormous tonnage within a limited time in oxidizing furnaces, considering space, facilities and labor available, exclude any such practice as suggested by Dr. Fay.

The plants, methods, facilities and help to handle the hot metal, the teeming and continuous and rapid progress of the whole process, to carry it within a limited space of time from the blast furnace to the finished product and get it out of the way as quickly as possible, does not admit of such a radical change. It would necessitate entirely new and much more costly plants, resulting in comparatively smaller product at a very much enhanced cost of production per ton.

Even if it were possible to make such a radical change, the desired result could not be obtained with present practice.

It is impossible to deoxidize the metal with methods available, or rather with the present practice in connection with oxidizing furnaces so thoroughly, as to remove all oxides of silicon and manganese formed as a result of the operation.

Even if pure pig iron was used, one would have to deal with more or less oxide gases and slag that could not be effectively and entirely eliminated. If I had the choice of steel rails, made from low-phosphorus and sulphur pig, finished in basic open-hearth furnaces, producing steel under 0.04 phosphorus and sulphur, I would prefer steel rails exceeding the above limit, provided the hot metal from the basic furnace had been finished and sufficiently rested in the electric furnace.

The little pockets containing these undesirable bodies in the finished steel are invisible in the rail, in the gun-tube or in any other product made from the metal. Some of them, and possibly the most pronounced ones near the surface, may be discovered at some stage during the process before or after reaching the finished stage, or by a destructive test. But it is not possible to apply such a test to every rail-bar or article produced, as only one can be destroyed out of a great many, and the one destroyed would prove nothing as regards the balance of the product.

As a chain is no stronger than its weakest link, any rail or beam or gun or boiler-tube, etc., is no stronger than the weakest spot that may be invisible to the eye and impossible to detect until through strain in service it suddenly gives away.

It is not my desire to repeat what I have pointed out repeatedly before in this journal and elsewhere, that it is not alone possible to overcome all these objections with the Héroult electric steel furnace, but the rapid increase of furnaces of this type already in continuous operation and under construction, subject to everybody's investigations, is proving this beyond doubt.

With modern power producing plants, hot metal from oxidizing furnaces can be purified and deoxidized in a Héroult electric furnace in a short time, producing a very pure material, free from slag and other injurious bodies; in fact, a material equal to best crucible steel, only more uniform, at a reasonable extra cost over open-hearth steel.

Owing to the very much higher value of crucible steel (more than three times the value of ordinary open hearth) it is, of course, not practical to purchase steel rails or similar large-tonnage products of material made by the crucible process.

Since the Héroult electric furnace, however, has been brought to the present high state of perfection and rail steel and other large tonnage products can be purified and refined at moderate extra cost over cheap raw materials, there is no good reason why a superior product could not be put on the market and sold with a reasonable advance over Bessemer and open-hearth steel. All this can be accomplished simply by adding Héroult electric furnaces to already existing Bessemer and open-hearth steel plants without any radical changes whatsoever.

The railroads as well as all other consumers of steel are constantly clamoring for better and more uniform products. If steel rails can be furnished of superior quality, giving better and longer service, reducing railway accidents, due to rail breakages, it would mean economy for the railroads and protection to human life.

The proportionate extra value of such steel rails can be established.

The Government should be the very first, along with the railroad companies, to take advantage in securing a superior and more uniform ordnance material, as most of the same, now supplied for guns and other war materials, is being made in oxidizing furnaces, principally open hearth.

If the Government specifications of war materials would call, in future, either for crucible steel or steel made in oxidizing furnaces, purified and refined in electric furnaces, to be equal to crucible steel, I am sure a better, more uniform and more serviceable material would be supplied at a reasonable advance over open hearth.

If the railroad companies would give notice that they are prepared to receive bids for steel rails, finished in electric furnaces, specifying low percentage of phosphorus and sulphur and free from slag, manganese-sulphide, etc., they would soon be able to obtain rails of much better and more uniform quality, giving much longer service and a corresponding decrease of accidents due to rail-breakages. The advance over present price of rails would not be unreasonable and would figure out a saving in comparison with the price of the present standard article.

This is an age of progress. The next ten years will witness an enormous increase in speed of railway traffic. Space will be annihilated. Our leading roads are busily engaged electrifying their lines within a considerable radius of the large cities, and this tendency will grow steadily. The Pennsylvania Railroad announces its intention of electrifying the distance between New York and Philadelphia, practically doubling the present speed. With such an enormous increase of velocity the resistance to wear and tear and the purity of the metal must be increased in proportion. This applies to the rails as well as to the rolling stock, axles, wheels, tires, etc. It does not alone involve the question of economy, but what is of even greater importance, the safety of human life. There is no doubt that the leaders of our great railway systems and steel interests are realizing that there is but one way of solving the problem; namely, by raising the present standard of rails and other railway materials.

Over 20 Héroult steel furnaces are now finished and under construction, of which more than half are actually in continuous operation, producing thousands of tons of high-grade steel and in many cases the finest quality of tool-steel, cutlery-steel, etc., from the very same raw material and the same oxidizing furnaces of which the steel rails of this country are being made. All that is necessary to do is to pass the hot metal through the Héroult electric furnace and instead of the present much abused article, steel rails of tool-steel quality will be obtained. Steelmakers, railroad officials, and all who are interested, are cordially invited to see it done.

New York City. R. H. Wolff.

New York Meeting of the American Electrochemical Society

In the first years of its existence, the American Electrochemical Society used to hold two meetings a year, one in Spring and one in Autumn, in different cities of the country. This was considered too much of a burden, and there were many suggestions to drop one meeting altogether and to hold only the meeting in Spring. A compromise plan was then adopted, according to which the general annual meeting was to be held in Spring at places changing from year to year and a second smaller meeting in Autumn in New York City, as it was thought that many members would visit New York anyway about this time of the year and could then arrange to attend the meeting.

It was doubtful at first whether a second meeting of secondary importance would be attractive enough to make it worth while; and the relative lack of success at the first trial, two years ago, made it even more doubtful. But the situation changed very remarkably last year, and after the renewed and really fine success, achieved at this year's meeting on October 30 and 31, the Autumn meeting in New York has probably now become a permanent institution.

Like all meetings of the American Electrochemical Society it was a meeting "bristling with good fellowship." The attendance was beyond 200; an alphabetical list of those printed on the last registry list will be found at the end of this report.

A great deal of the success was due to the endeavors of the cordial hosts of the Society—on the first day, the College of the City of New York and the staff of its Department of Chemistry, with Dr. Chas. A. Baskerville as its head; on the second day the Chemists' Club of New York City, which lives up to its fine programme of endeavoring to become the professional home of all the chemists of the United States.

The two sessions of Friday, October 30, were held in the Doremus laboratory of the Department of Chemistry of the College of the City of New York. During the morning session President John H. Finley of the College welcomed the Society in a felicitous little speech, comparing in a very clever and humorous way chemical training of days gone by and of today. In the afternoon Dr. Baskerville sketched the engineering features and the organization of the Chemistry Building of the College of the City of New York. We intend to give an illustrated description of the Chemistry Building of the College in one of our next issues.

During the noon recess between the two sessions the members and guests were entertained by the staff of the Department of Chemistry at luncheon and later enjoyed an organ recital by Prof. S. A. Baldwin, head of the Department of Music, in the auditorium in the Main Building.

The session of Saturday morning was held in the lecture hall of the Chemists' Club. During the afternoon of Saturday an excursion was made to the Balbach Smelting and Refining Works in Newark, N. J., where the processes of smelting and refining of copper, lead, silver and gold were shown in operation. This was the third visit of the Society to one of the large electrolytic copper refineries near New York, the copper refining plants of the American Smelting and Refining Company and of the United States Metals Refining Company having been visited in previous years. Like these two, the Balbach works are operated on the multiple system of cells. (A full illustrated description of the Balbach refinery was given in our Vol. II, page 303. Concerning the Balbach process of parting silver and gold see also our Vol. III, page 374.)

The visit to the Balbach works was of especial interest since this is the first electrolytic copper refinery in the United States, having started operation 25 years ago. It was a great pleasure to the members of the Society to shake hands with the pioneer of American copper refining, Mr. Edward Balbach, Jr. The visitors were taken through the works in numerous small parties, led by officials and engineers of the company, who proved excellent guides.

PHOTOGRAPH TAKEN BEFORE THE CHEMISTRY BUILDING OF THE COLLEGE OF THE CITY OF NEW YORK.

Of the purely social features of the meeting we mention the informal and highly enjoyable smoker tendered to the Society by the Chemists' Club on Saturday evening, and the subscription dinner on Friday night at Reisenweber's in which more than 700 participated. From the several after-dinner speeches we quote the following of President E. G. Acheson:

E. G. ACHESON ON THE AGE OF ELECTROCHEMISTRY.

"I think this an opportune moment to invite your attention to a subject that should be of interest to all of us.

"A young man wishing to devote himself to an established electrical industry would, twenty-eight years ago, have had to make a choice between electroplating, telegraphy, medical battery manufacturing, or the then recently established telephony. In the public press at that time appeared the first flashes from the incandescent electric light and the distant rumbling of electric traction. Our profession was then represented by electroplating, and it was not until 1888 that electrochemistry took its

first decided steps to attain its proper place among the industries of first magnitude. A very great deal has been accomplished during the years since that date—the annual production of electrochemical products now amounting to many millions of dollars—and I think we can confidently look for greater results in the near future.

"A great national movement was recently started to conserve our national resources, and no one should take a more prominent place in the proposed work than the electrochemist. Following the hydraulic and electrical engineers, the electrochemist should, by means of the electrical energy resulting from the utilization of our water powers, transform many of the chemical and metallurgical industries, as they now exist, into electrochemical and electrometallurgical ones, and he should greatly extend the list of products now used in the industrial world.

"Mr. James J. Hill, in his address at the Governors' Conference called by President Roosevelt last Spring, stated that, 'Fifty years ago the annual per capita production of coal was a little more than one-fourth of a ton. It is now five tons.' It will be largely through the work of the electrochemist that this rapid consumption of our coal supplies will be arrested.

"While reading Circular 157, issued by the Forest Service of the United States Department of Agriculture, I was caused to liken the consumption and destruction of our natural resources by the present generation to the waste and devastation left in the path of a swarm of locusts, and surely, if this destruction be continued, posterity will severely criticise us. Mr. H. St. Clair Putnam, in an address at the Conference of Governors stated, 'The full development of all the water possibilities of the country would, according to expert estimates, furnish a power equalling and probably greatly exceeding five times the present total horse-power of all kinds, or 150 million horse-power.' We cannot fail of being impressed with the immensity of the field for operations of the hydraulic and electrical engineers and the electrochemists in the harnessing and utilization of this tremendous power, and through its proper utilization the present wasteful consumption of our natural fuels should cease.

"It should not only do our transportation and manufacturing, but, as formerly stated, greatly add to the number of our manufactured products, placing as it does in our hands the attainment of the highest possible earthly temperatures for the breaking up of the old and the forming of new chemical combinations, thus, through the electrochemist, mastering the fixation of the nitrogen of the air we will have the means of insuring the continued fertility of the earth to meet the require ments of posterity. Even now the world is under obligations to us in a measure not generally realized. Thus, the great glare of light that lights the automobile on its flight was made commercially possible by electrochemistry.

"In Circular 157 I have mentioned, the author states: 'This is the beginning, the engineers tell us, of the age of electricity and that means the beginning of the age of water-power,' and to this should be added, 'and that means the beginning of the age of electrochemistry.' What a great age it will be! We, the men of to-day, are just breaking the ground. To our children we will bequeath a valuable heritage, and the proper preparation of the succeeding generations for the successful furthering of this work largely devolves upon the ladies—the mothers—their influence on youth far transcending that of the fathers. Can we justly estimate their beneficial influence upon the men of their own generation?

"I remember having once seen an old print in which was portrayed a scene in Michael Faraday's laboratory. The time was late in the night. Faraday had just produced an electric current by induction, and on breaking the circuit obtained a bright spark. So thoroughly did he appreciate his discovery and so happy was he over the achievement, he at once went and aroused his wife that she might share in the pleasures of his triumph. It is conceivable that Mrs. Faraday would have preferred to continue her slumbers, but can we know to what extent her apparent interest influenced her husband in continuing his classical researches that made possible practically all of the present electric age, and the electrochemical age now dawning."

In the following we give abstracts of all the papers presented at the meeting. The papers presented at the Friday morning session related to various subjects of scientific interest.

Mercury Cathode for Electro-Analysis.

The first paper presented related to the use of a mercury cathode in the determination of metals, the authors being A. Harold Porter and Francis C. Frary, of the University of Minnesota. In the absence of the authors the paper was presented in abstract by Prof. J. W. Richards.

The chief results are as follows: The electrolytic determination of zinc in a mercury cathode gives low results, due to loss of both zinc and mercury in the process of washing with alcohol and ether. Pure mercury does not lose weight appreciably when washed with water, alcohol and ether, nor by liberation of hydrogen on its surface even at high temperatures (100°). The loss in weight during washing seems to be peculiar to zinc, since copper amalgam shows no signs of it, and the determination of copper by means of the mercury cathode is quite satisfactory.

Determination of Zinc.

Following the paper by Porter and Frary, Prof. Walter T. Taggart, of the University of Pennsylvania, read a paper by Miss Lily G. Kollock and Dr. Edgar F. Smith on the determination of zinc with a mercury cathode and a rotating anode.

The authors give details to be observed in order to insure complete precipitation of zinc. The cup must be clean; use 50 to 60 grams of pure mercury; keep cup covered with watch glasses; electrolyze the solution of zinc sulphate diluted to about 10 cc with current of 1 to 3 amp and 8.5 to 5 volts for 12 to 15 minutes; rotate anode 550 to 750 times per minute. When the decomposition is completed the motor is stopped, the cover glasses removed, and distilled water poured into the cup from the wash bottle and the liquid siphoned out until the level almost reaches the spiral portion of the anode. The cup is then refilled with distilled water and the operation repeated until the current falls to zero—300 c. c. of water being used for the purpose. The acid liquid must be removed before the current is broken. Pour off the water remaining and wash quickly three times with absolute alcohol and two or three times with absolute ether; place in desiccator and finally weigh.

Thirty-seven determinations of a solution containing 0.1316 gram zinc gave an average of 0.13155 gram zinc. No zinc or mercury was found in the water, alcohol or ether washing.

In discussing the paper of Porter and Frary, Dr. Patten emphasized that the area of the mercury cathode used should be given, with exact dates on voltage, current and current density. The papers were also briefly discussed by Dr. J. W. Richards.

Passivity of Iron and Nickel.

A paper by Prof. E. P. Schoch, on the passivity of iron and nickel, was presented in abstract by Dr. Patten. The author first sketched various theories of the passive state—the oxide film theory of Faraday; the valence theory of Krueger, Finkelstine and Mueller, which finds the cause of passivity within the metal itself; and the various reaction-velocity theories, of which Le Blanc has given the general formulation, while the special formulation of Fredenhagen and of Muthmann and Frauenberger emphasizes the slow velocity of reaction between oxygen and metal, so that oxygen accumulates, and a lower potential is obtained. Sackur, on the other hand, has emphasized the slow reaction between oxygen and hydrogen within the metal.

Experimentally the problem of the passive state may be attacked by either of the following methods: (1) Relation of current density to polarization at anode in various electrolytes;

(2) measurement of capacity (electrostatic); (3) optical properties of the anode surface with reference to film formation; (4) effect of alternating-current electrolysis; (5) catalytic influence of the metal upon the union of hydrogen and oxygen; (6) conditions under which a metallic oxide is formed at the anode; (7) effect of mixed electrolytes, as in Luckow's phenomenon.

(1) In the main metals are more readily made passive in alkali solutions, but iron and nickel and many others may be rendered passive in acid solution. The critical current density at which a metal becomes passive increases in general with the concentration and with the temperature. But at high concentrations or at high temperatures the passive state is sometimes not attained.

(2) The condenser effect at the anode may be measured and the leakage current through the film may be determined. But Dr. Schoch says that the presence of a condenser effect does not necessarily require a film on the anode, since an oxygen layer would give the same effect.

(3) Optical determinations decide nothing according to Dr. Schoch.

(4) As to the effect of alternating-current electrolysis, Ruer has recently found that platinum dissolves when subjected to alternating current in an electrolyte. His idea is that by anodic reaction a platinum oxide is formed. But on reversing the current, the oxide is partly reduced to another basic oxide, soluble in the electrolyte. An oxide of platinum was isolated which would produce passivity.

(5) Sackur found that with respect to the catalytic effect of metals on the union of oxygen with hydrogen the metals arrange themselves in the order Ag, Pt, Cu, Sn, Fe, Ni, Cr.

(6) As to an oxide film, Dr. Schoch says that recent work and general knowledge make it probable that oxide is formed first in the electrolyte and then deposited on the anode.

Dr. Schoch made measurements of the electrode potentials. Nickel with occluded hydrogen gives —0.48 tc —0.88 volts in normal $NiSO_4$; nickel with occluded oxygen gives below —0.48 volt. Exposure to air gives about —0.25 volt. Various oxidizing agents lower the potential according to their oxidizing power.

The same considerations hold for iron. Cushman showed that iron takes oxygen from $K_2Cr_2O_7$ and lowers its potential.

Dr. Schoch has determined the equilibrium potential of nickel in an oxygen-free neutral normal solution of nickel sulphate and ascertained the effect upon the potential of various current densities, securing equilibrium in each case. Then the same was done with various additions to the nickel sulphate solution. The equilibrium point was found to be lower in acidified than in neutral solutions. Concerning details of Dr. Schoch's investigation reference must be had to the complete paper which will be published in the *Transactions*. The paper was briefly discussed by Dr. Bancroft and Dr. Patten.

Chemical Energy.

A paper on this subject by Dr. J. E. MILLS, of the University of North Carolina, was presented in abstract by Dr. J. W. Richards.

Dr. Mills, who has published during the last years a series of highly theoretical papers in Dr. Bancroft's *Journal of Physical Chemistry*, explains in the present paper his theories by applying them to the special case of the reaction between 16 grams O and 2 grams H at 0° C. under atmospheric pressure, forming 18 grams H_2O and setting free 68,511 calories. At other temperatures and under other conditions of pressure and volume the amount of heat given out would be different. From whence came the heat given out by the reaction? Why and how does the amount of heat given out vary under different conditions? Why does not the reaction take place when the hydrogen and oxygen are first mixed? Why is an electric spark needed to start the reaction?

The total heat necessary to raise 2 grams of hydrogen and 16 grams of oxygen and 18 grams of H_2O (ice) from —273° C. to 0° C. is calculated to be

2,125	calories	for	2 grams H
1,972	"	"	16 grams O
2,887	"	"	18 grams H_2O

The 18 grams of water at 0° C. contains, therefore, at least 2,887 calories, and since 68,511 calories of heat were given out by the reaction of the hydrogen and oxygen gases at 0° C. these gases before the reaction contained at least 71,398 calories of energy.

Of this total amount of energy, 2,125 calories were supplied to the 2 grams of hydrogen, and 1,972 calories to the 16 grams of oxygen in converting them from the solid condition at —273° C. to the gaseous condition at 0° C. This is a total of 4,097 calories. It follows, therefore, that while in the solid condition at —273° C. the oxygen and hydrogen contain at least 71,398 — 4,097 = 67,301 calories of energy.

The author now sketches his views why 4,097 calories of energy were necessary to change the temperature and condition of the hydrogen and oxygen as described. Without going into details of the author's calculations, he finds that we have for the total energy necessary to change 2 grams of hydrogen from the solid condition at —273° C. to the gaseous condition at 0° C. under 760 mms pressure:

Energy necessary to overcome external pressure	= 542.1	calories
Energy necessary to overcome molecular attraction	= 261.1	"
Energy necessary for translational motion	= 814.0	"
Energy necessary for internal work	= 514.6	"
Total	2,136.8	calories

This agrees exceedingly well with 2,125 calories, found above.

An exactly similar calculation for the oxygen gives 1,802 colories, instead of 1,972.

Unfortunately, the author's calculations cannot be extended to water, for it is an associated substance.

Except for the discrepancy of 170 calories, he has "shown why and how the 4,097 calories of energy added to the hydrogen and oxygen to change them from their condition at —273° C. to their condition at 0° C. were expended, and have, therefore, in part at least, answered the question as to why and how the amount of heat given out by the reaction of the hydrogen and oxygen will vary under different conditions of volume, temperature and pressure."

"The answer to the third question as to why the reaction did not take place when the hydrogen and oxygen were first mixed and before the passage of the electric spark, has doubtless occurred to everyone. It was first necessary to loosen the union of some of the hydrogen atoms from their combination with other hydrogen atoms, and the union of some of the oxygen atoms from their combinations with other oxygen atoms. Then once free, the hydrogen atoms and the oxygen atoms unite, and in so doing give out enough heat to loosen the neighboring hydrogen and oxygen molecules, and these in their turn unite, and thus the reaction is propagated.

"But it is perhaps not so clearly recognized that the force which we call chemical affinity is probably never directly affected by a rise in temperature. Certainly in the case under consideration we have accounted for all of the energy added to the hydrogen and the oxygen from —273° to 0° C., save 170 calories, as having been used to effect external work, overcome molecular attraction, and effect an increase in the translational and internal motion of the molecules, and the original 67,300 calories possessed at —273° C. appears to have been held,

intact as it were, neither increased nor diminished, by the changes of temperature, pressure and volume necessary to raise the hydrogen and oxygen to their condition at 0° C."

The author, therefore, appears to advocate the general rule that the energy of a reaction can always be considered as the sum of two quantities, one being the energy of "chemical affinity" and being independent of the temperature, etc., the other being the equivalent of the external and internal work of the physical change from absolute zero to the conditions of the experiment.

The paper is concluded by some general discussions on chemical energy.

In the following we give an alphabetical list of the names contained in the last printed list of members and guests in attendance:

The paper was briefly discussed by Dr. J. W. Richards and Dr. L. F. Guttman.

Equilibria in Standard Cells.

A paper on this subject was presented by Dr. G. A. Hulett, of Princton University.

Previous work had given some evidence which indicated that the cathode system of the Weston or cadmium cell was in unstable equilibrium. The materials used are cadmium sulphate, mercurous sulphate, mercury and water; and they should form a non-variant system at any temperature, provided there was no other reaction than the formation of a saturated solution of the two salts.

It was found, however, on rotating this system that the potential between the mercury and the solution did not remain constant, but showed an increasing value which indicated that the mercury concentration in the solution was slowly increasing and this change was thought to be due to a slow hydrolysis of the mercurous sulphate. This view was strengthened by the observation that the addition of sulphuric acid to the system entirely prevented the changes caused by rotating the system.

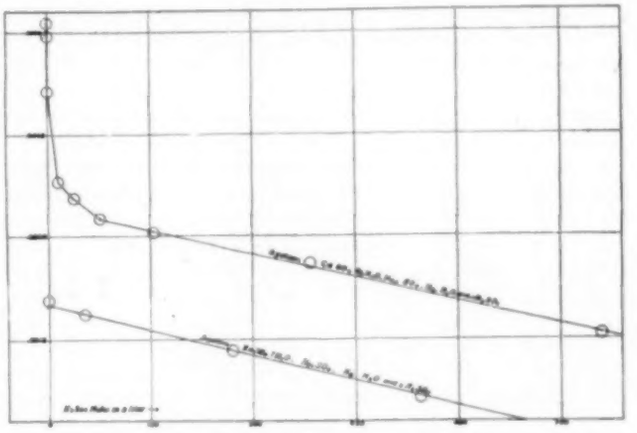
All the evidence obtained was based on the change of potential between the mercury and the solution, but further evidence has now been obtained by analyzing the solution. A method was devised by which it was possible to obtain an exact determination of the mercury in the cathode system of the cadmium cells and the solution has been analyzed for $CdSO_4$, Hg_2SO_4, and water, also the density, conductivity and potential of the solution against mercury was determined. The solution from the rotated system was found to contain an excess of mercury amounting to 30 per cent of the normal solubility.

Also systems to which known amounts of acid were added were brought to equilibrium at 25° and the solutions analyzed and thus the concentration of $CdSO_4$ and $HgSO_4$ as a function of the H_2SO_4 concentration was obtained. The cadmium sulphate gave a continuous curve, its concentration decreased uniformly with the increasing acid concentration, but the mercurous sulphate curve showed a distinct break at 0.08 moles of sulphuric acid in a liter. The curve for greater concentrations than this was a straight line showing an increasing concentration of mercury in the solution with a decreasing acid concentration while at 0.08 moles of acid in a liter the curve took a sharp upward turn indicating that hydrolysis takes place whenever the acid concentration is less than value. These results quite confirmed the conclusions drawn from the rotation experiments and gave quantitive data which explained the behavior of the cadmium cells, in particular the fact that some of these cells go to a very low value, and also the appearance of a yellow coloration in the paste.

Similar experiments were made on the cathode system of the Clark cell, but the curve of mercury concentration in the solution, as a function of the acid concentration, did not show irregularities and thus confirmed the rotation experiments with this system. These results indicated that the cathode system of the Clark cell was reversible, while the cadmium cell was not, and some direct experiments to test this conclusion were made and showed that the conclusion was correct.

Cadmium and Clark cells have been made at intervals for five years, according to the specifications proposed by Carhart and Hulett (*Trans.*, Amer. Electrochemical Soc., 5, 59). The main object of these specifications was to avoid the presence of the basic salt in the depolarizer. The reproducibility of the Clark and cadmium cells has been about the same—1 part in 50,000—but the Clark cells have been the most constant.

The cadmium cells made at the various times now show values ranging from 1.01843 to 1.01827 (25°), and this does not include any of the cells which had fallen to a very low value and were rejected. Some cadmium cells have been made with sulphuric acid and these have been more constant, but for accurate work one must have a constant temperature bath for either cell and with modern thermostats the old objection to higher temperature coefficient of the Clark cell has lost its force. The unsaturated cadmium cell which has practically no temperature coefficient is the most satisfactory laboratory instrument (*Phys. Rev.*, 27, 33). For very accurate work the value of this standard battery may be controlled from time to time by a standard cell.



STANDARD CELL CURVES.

Some remarks on the paper regarding applications of the phase rule were made by Dr. W. D. Bancroft.

Fixation of Atmospheric Nitrogen.

Prof. G. W. Morden, of the University of Toronto, Canada, presented an interesting paper on the formation of nitric acid from air by means of low-voltage direct current. This investigation was carried out in the laboratory of Prof. Haber in Karlsruhe, Germany.

The use of the low-voltage, direct-current arc for oxidation of the atmospheric nitrogen is a novel and very interesting departure and the success obtained by the author on a small laboratory scale is significant. Unfortunately the paper had not been printed in advance, and we are therefore unable to give here the tables of figures in which the results of the author are summed up. We intend to give them in a future issue.

However, the leading idea of the work done by Dr. Haber and his co-workers in connection with the Badische Anilin u. Soda Fabrik may be sketched here. (See also Haber and Koenig, *Zeit. f. Elektrochemie*, Oct. 9, 1908.) Formerly it has been supposed that the reaction between the nitrogen and oxygen in the air is a purely thermal effect; i. e., the electric discharge produces a very high temperature and at this very high temperature a mixture of oxygen and nitrogen is in chemical equilibrium only if it contains a certain proportion of nitrogen oxide. This proportion is the higher the higher the temperature. Hence, when the electric discharge passes through air, the air is heated and an amount of nitrogen oxide is formed, corre-

sponding to the equilibrium at this high temperature. If now the mixture of air and nitrogen oxide would be slowly cooled, the reverse reaction would take place; the nitrogen oxide would be dissociated again and the useful work would be undone. If, however, we cool the mixture of air and nitrogen oxide very suddenly, the reverse reaction has not time to go on. And if the gas mixture is cooled very suddenly to a sufficiently low temperature then at this low temperature the reaction velocity between the different constituents of the gas mixture is so low that the constitution of the mixture undergoes practically no further change. To borrow a term from steel practice, we have quenched the gas mixture and thereby frozen the equilibrium corresponding to the original high temperature. This view seems to be, indeed, the correct one for all processes (like the Birkeland-Eyde process) in which a very high temperature, that of the electric arc, is made use of. All such processes must therefore be based on two principles: first, to produce as high a temperature as possible, and then to cool as suddenly as possible.

However, it seems now that the above theory does not tell the whole story. By electric discharges at lower temperatures it is possible to produce a concentration of nitrogen oxide in the gas mixture greater than would correspond to the pure thermal equilibrium at that temperature. It seems, therefore, that besides the thermal effect we have a specific electric effect (perhaps an "ionic reaction"). At high temperatures the thermal effect prevails, at lower temperatures the specific electric effect. At lower temperatures we have, according to Haber and Koenig, an "electric equilibrium" different from the "thermal equilibrium." To the electric equilibrium corresponds a higher proportion of nitrogen oxide in the gas mixture than to the thermal equilibrium. The electric equilibrium in order to exist requires, however, the supply of a certain amount of energy per unit of time.

Haber and Koenig (*Zeit. f. Elektrochemie*, Oct. 9) succeeded to get the uncommonly high nitrogen oxide content of 10 per cent from ordinary air and 14½ per cent from a mixture of equivalent amounts of nitrogen and oxygen; and these results were obtained at temperatures which were not more than a few hundred degrees above the melting point of platinum. This is a temperature region in which the dissociation of nitrogen oxide is relatively slow. Haber and Koenig used a cooled high-tension arc at reduced pressure.

Prof. Morden's results, obtained with a low-tension direct-current arc, also appear to point to a specific electric effect, different from the thermal effect.

The chief result of this whole series of investigations appears to be of practical importance. It means that it may no longer be necessary to use extremely high temperatures, so that the great difficulty of the sudden cooling is avoided. It also means that we can hope to get at lower temperatures better results than could be expected on the basis of the pure thermal theory.

The paper of Prof. Morden was discussed by Messrs. Cushman, Lidbury and Guttmann mainly with respect to the arrangement of the experiments.

Corrosion of Iron and Remedies.

The afternoon session was almost completely devoted to a symposium of papers on the corrosion of iron.

Prof. A. F. GANZ, of the Stevens Institute, introduced the subject by a general discussion of "the corrosion of underground structures." He distinguished between corrosion due to an electric current from an outside e.m.f. (for instance, electric stray currents from tramway rails used as return circuit), and corrosion without an outside source of e.m.f. The latter is generally called common rusting. This distinction is simply practical. It has nothing to do with the theoretical question, whether all corrosion of iron and steel is essentially an electrolytic phenomenon or not.

An electrical engineer, called to report on a case of alleged electrolytic corrosion due to stray currents, has first to make potential measurements to determine the electrical conditions of the system, and if he finds that there is danger of electrolytic corrosion due to the current leaving the iron structure at some point he has to propose remedies.

Prof. Ganz called attention to a ridiculous method of electric testing which has been employed by certain "experts" in electrolysis reports in this country. They measured the potential difference between the rail and the gas or water pipe alleged to be in danger, then measured the resistance between the same points and called this the earth resistance, and then derived by Ohm's law an absurd value for the current alleged to flow from rail to pipe; this was done from block to block and by adding all the currents thus calculated, an absurd value of total current was found.

The steel foundations of buildings have not the same opportunity to pick up stray currents as gas or water pipes, but there may be danger in certain cases when the steel structure is in contact with gas or water pipes. It seems a safe rule to insulate the steel structures of buildings from piping systems.

Prof. Ganz then made some suggestions as to possible remedies and discussed their dangers. He then proposed the following five questions, which are important and which should be answered by electrochemists:

(1) Are there any practical cases of iron buried in street soils where the iron is in the passive state, or are these conditions always such that the iron is active, so that we can correctly estimate the weight of iron destroyed on the basis of 20 lb. per amp-year? Is there any practical method by which the iron can be rendered passive? Lime has been suggested and the question is raised whether any such method can be applied in practice.

(2) Is there any means by which we can identify positively corrosion produced by electrolysis from stray currents as distinguished from corrosion produced by natural causes?

(3) Can an iron structure be coated in such a way as to protect it permanently from electrolytic corrosion? It is claimed that attempts to coat with paints, pitch, tar, etc., have failed. Is this failure due to actual defects in the coating, although these may appear perfect? Can corrosion of iron once begun continue if the iron is imbedded in a heavy coat of material, like pitch or asphaltum?

(4) Can the continuity of an underground iron system, such as a system of gas or water pipes, be sufficiently broken up in a practical manner to render these safe from electrolysis?

(5) What is a safe current density, per square foot of pipe surface, leaving pipe which will not produce an appreciable destruction from electrolytic corrosion?

In the discussion which followed, Messrs. Cushman and Toch emphasized their conviction that all corrosion is electrolytic in nature. With respect to question (3) of Prof. Ganz, Mr. Maximilian Toch referred to a pipe line of a natural gas company in Illinois. This pipe had been coated inside and outside with asphaltum, but it had been overlooked that natural gas is a powerful solvent for all bituminous compounds. The pipe naturally became clogged and useless after a time. Mr. Toch believed that it was quite feasible to thoroughly protect an iron structure against any possibility of corrosion, if only the interested parties are willing to pay for it.

Prof. Ganz mentioned a special case in which a single pitting in a pipe caused $50,000 damage indirectly. In such cases companies would certainly be willing to spend any reasonable amount of money for protection of their pipes, though such expensive methods might not be recommended for gas and water pipes in general.

Mr. Carl Hering answered question (5) of Prof. Ganz by the decisive statement that there is no safe minimum current density. Whatever the current density, when current leakes from pipes into wet ground, it will cause corrosion and if the action lasts only long enough destruction of the pipe will result. A possibility of protecting an iron pipe is to put it in metallic con-

tact with a block of zinc buried in the ground; for well-known electrochemical reasons any current passing through the pipe will tend to pass out into the ground from the zinc, instead of from the iron. The iron is thus protected, but at the expense of zinc, and the protection ceases when the zinc has been consumed. If pipes are properly coated with a paint or the like, the electrolyte in the earth may be prevented from coming into contact with the iron pipe, but there is always danger that by some mechanical accident the paint coating is scretched off or otherwise removed, and such places become naturally places of serious danger. When a pipe is found in danger in one place, it may be protected there, but great care should be taken to see that the danger is not simply shifted somewhere else.

With respect to question (2) of Prof. Ganz, Mr. R. H. Gaines mentioned the case of a pipe line in New York State where the appearance of corrosion was just that of corrosion due to stray currents, yet there was no tramway line in the neighborhood, and the millivoltmeter did not indicate a potential difference between rail and ground.

Messrs. Roberts, Bancroft and Sadtler also participated in the discussion. Mr. S. S. Sadtler referred to an interesting case where corrosion resulted at a point where current was entering the pipe, not leaving it, i. e., where the pipe was cathode. The explanation was that the ground contained a sodium salt. The sodium set free at the cathode alloyed with the iron and this alloy disintegrated chemically.

Dr. Clayton H. Sharp, of the Electrical Testing Laboratories, of New York City, then presented a paper of "correct methods for measuring stray currents."

The investigation of the electrical conditions of a system of water or gas pipes in the ground is not easy. The chief thing to find out is whether at any point any considerable amount of electric current leaves the pipes. The principal measuring instruments available for such tests are the voltmeter and the millivoltmeter. They have been used by would-be "experts" with alarming results, but when properly employed they can give valuable indications.

When the voltmeter shows that the rails of a trolley line are positive with respect to the system of pipes, the pipes are safe. On the other hand, if the pipes are positive with respect to the rails or other steel structures, the pipes may be in danger. But danger does not necessarily exist in this case, since the pipes may be embedded in dry sand and thus insulated.

The determination of the current flowing in a piping system is more difficult. The easiest way would be to insert an insulating joint in the pipe and connect the ammeter to points at both sides of the joint. But this is often not feasible. It is then necessary to employ an indirect method.

One indirect method is to measure the potential drop along the line. If the ohmic resistance per unit length of pipe is known, the current in the pipe is found by Ohm's law. But the measurement of resistance per unit length is the difficulty in this case. However, it may be estimated from the size of the pipe and from an average value of resistivity, although the resistivity varies considerably in practice.

In some cases it is possible to connect by wires two points of the pipe with an ammeter. The potential difference between the points of connection is measured both when the ammeter circuit is closed and when open; and in the latter case the current is simultaneously measured. In the latter case the potential difference is smaller than in the first case, and from this difference the resistance of the pipe between the two points of connèction may be found. For instance, if the potential difference with closed ammeter circuit is half the potential difference with open ammeter circuit, it follows that the current flowing originally in the pipe is twice that indicated by the ammeter reading.

However, more important than the current flowing through a pipe is the current leaving the pipe. Important information may be obtained by determining the electric conditions of the soil in the vicinity. By determining the potential gradient around the pipe we do not disturb the electrical conditions in the soil, and if we find that there is a continuous drop of potential, by passing from point to point away from the pipe, we can conclude that current flows away from the pipe. Non-polarizable electrodes should be used in such cases.

Dr. Haber's "earth ammeter" is valuable, but would seem to change the electrical conditions in the soil.

Dr. Sharp's paper was discussed by Mr. Hering, who doubted the practicability of the shunt method. Dr. Sharp answered that it can be used in some cases and not in others. We have no standard method which can be used in all cases, but must adapt the method to the conditions of each special case.

Mr. A. A. Knudson then presented a paper describing some particular cases of the corrosion of the bottom of oil tanks and some other structures. The paper was briefly discussed by Messrs. Sadtler, Hering, Cushman, Burgess, Walker and Richards. Mr. S. S. Sadtler referred to the usual conditions of the soil around an oil tank and thought that a good deal of the corrosion may be purely chemical, that is, not caused by external stray currents.

Dr. W. H. Walker, of the Massachusetts Institute of Technology, then presented a very interesting paper on "the function of oxygen in the corrosion of metals."

Dr. Walker spoke in a very forceful and interesting way and first criticized severely a recent investigation in which it was claimed the electrolytic theory of the corrosion of iron had been refuted.

Dr. Walker then discussed the function of oxygen in the phenomenon of corrosion. This function is twofold. Oxygen is necessary for rusting; according to the electrochemical theory the first action is the passing of iron into the ferrous ionic state, with simultaneous liveration of hydrogen; the ferrous ions are then oxidized to the ferric state by oxygen in the atmosphere, with its subsequent preciptation as ferric hydroxide. This is the evident secondary function of oxygen.

But according to Dr. Walker oxygen also has to fulfill a primary function in the corrosion of iron.

The rapidity with which iron will pass into solution in water depends not only upon the electrolytic solution pressure of the iron and hydrogen and the osmotic pressure of the iron ions already in solution, but also upon the "excess voltage" (überspannung) which is required in order that the hydrogen ion which passes from the ionized condition may be set free. In this case there is a counter e.m.f. which must be overcome before the hydrogen can be liberated. It is possible, therefore, that the quantity of iron which can dissolve in water is limited to that amount which is equivalent to the hydrogen necessary to polarize that portion of the specimen which acts as the cathode. If this is so, it must be possible to make a solvent action continuous by the addition of any reagent which will dissolve the hydrogen-covered cathode portion.

The primary function of oxygen is, therefore, to depolarize those cathodic portions of the iron upon which hydrogen tends to precipitate. Dr. Walker described some instruction experiments quite similar to those described by him in our Vol. V, page 364.

In the second part of his paper Dr. Walker discussed several practical problems. One of these was the corrosion of barb-wire fencing. The zinc protects the iron, but at the expense of the zinc. The more rapidly zinc passes into solution, the more iron surface is exposed, and so on. The zinc-iron alloy (produced in the hot galvanizing process) dissolves with greater rapidity than pure zinc. To solve the problem of the corrosion of barb-wire fencing, Dr. Walker suggests to deposit zinc on the ends of the barbs by a special short treatment in wet galvanizing tanks.

Incidentally it was remarked that manganese in contact with iron protects the iron. But if manganese is found in steel, it means the presence of other impurities.

Mr. Maximilan Toch, of the well-known firm of Toch

Brothers, finally presented a paper on "simple methods for the prevention of electrolytic corrosion," principally by the use of paints.

The chief point, according to Mr. Toch, is that if it is possible to keep water away from the steel structure, no corrosion can result.

As to the protection obtained with concrete, Mr. Toch explained that we should not say that concrete protects, but that cement protects.

If a steel pipe or structure is first painted with an insulated paint and then embedded in pure cement, this covering should protect it for all time.

Mr. Toch said that he had not found that the chromate treatment of Dr. Cushman prevented corrosion. Steel beams and other materials are subject to so much rough handling in course of transportation that a very thin inhibitive surface film cannot be expected to afford a really lasting protection.

Electrolytic Paints.

Dr. WILDER D. BANCROFT, of Cornell University, in a paper on "the theory of electrolytic paines," gave an outline of the work which he proposes to undertake. The objection generally raised against electrolytic white lead is that it absorbs too much oil.

Dr. Bancroft thinks we should first make white lead that beats the standard and then consider the cost. It is really ridiculous that we should not be able to make on a small scale in the laboratory the ordinary white lead of commerce.

The principal thing in the experimental research is to study in detail the effects which a change of the different conditions of the experiment has on the properties of the product. For instance, the effect of variation of temperature should be thoroughly studied, and the other conditions should be similarly varied.

In experiments with copper oxides, Dr. Bancroft succeeded in producing a wide range of different colors by changing the conditions.

The Lash Steel Process and the Electric Furnace.

The first paper of the Saturday session was presented by Mr. F. A. J. FITZGERALD, of Niagara Falls.

His paper was not intended to do more than give a description of the general principles of the Lash process and describe briefly certain experiments on its application to the electric furnace. (See our Vol. V, pages 279, 322, 344, 378, 440, 455, 479 concerning further details of the Lash process.)

There are certain misconceptions as to what the Lash process is, and also it is not obvious at first sight why it might be of interest to the electrometallurgist. As regards its use in the open hearth, little may be said here beyond mentioning that the experiments, made on a commercial scale at several steel plants, have been successful in demonstrating its usefulness. "As might be expected, a process of this kind inevitably gives an opportunity to the person who is convinced that he did the same thing twenty or thirty years ago, but discussions on that subject are of more interest to the archeologist or mythologist than to the electrometallurgist, and in any case are not usually profitable."

The broad principle of the Lash process consists in making an intimate mixture of ore, cast iron and carbon and submitting this mixture to heat, when, if the proportions of the constituents of the mixture have been properly adjusted, the desired grade of steel is produced. The essential features in the process seem to be the fine state of division of the constituents of the mixture, their intimate association and the use of iron containing metalloids in considerable quantities.

It is unnecessary to comment on the advantage of having the various reagents in a fine state of division and intimately mixed, for the value of such a condition may be readily appreciated; but the use of iron, containing metalloids, is worthy of more extended notice. According to Lash (U. S. Patent 860,922, December 28, 1906): "The action of the pig or cast iron in the finely divided mixture is two-fold in character: First and primarily the pig iron contains a high percentage of metalloids and, generally, manganese, which elements upon the fusion of the iron are presented to the oxide in the most intimate and effective condition possible and become active and ready reducing agents. Secondly, the fused pig iron seems to act simultaneously as a solvent for some of the free carbon, and as an enveloping coat for the individual particles of oxide, thus bringing such dissolved carbon into intimate association with the oxide to supplement the effect of the metalloids already contained in the pig iron, in their reducing action."

Thus, according to this hypothesis as to the working of the process, the finely divided iron acts as a carrier of the carbon and the reactions might be represented by an equation as follows:

$$3Fe_3C + Fe_2O_3 + 3C = 3Fe_3C + 2Fe + 3CO$$

It follows then that during the reaction all the iron present in the metallic state contains carbon in excess of that required in the finished product till towards the end, when the free carbon

FIG. 1.—HÉROULT FURNACE TAPPED.

is completely exhausted and there is simply a mixture of iron high in carbon and unreduced oxide. Finally, this mixture reacts and the desired quality of steel is obtained. While the reactions which actually take place are no doubt far more complicated than this hypothesis of the working of the process, yet the experiments which have been made seem to demonstrate the usefulness of the supposition.

In practice there are many details which have not been mentioned as, for example, the addition of fluxes such as lime and fluorspar to the mixture; the use of sawdust, which is carbonized in the furnace and leaves the mass in a porous state so as to permit of the ready escape of the gases formed; the use of coal tar or any other suitable material to prevent the separation of the constituents of the mixture from each other because of their widely-differing specific weights or to act as a binding material in briquetting. These details, however, need not be considered at present.

In the application of the Lash process to the open-hearth furnace the saving effected is due to the lower cost of a unit of iron in the form of ore, than in that of pig or some forms of scrap. From this it follows that, other things equal, the less pig iron and the more ore that can be used the cheaper will be the steel produced. As to the arguments which may be advanced, that the process cannot compete with an open-hearth furnace fed with molten pig iron, or with other modifications of the open-hearth furnace, they are foreign to the present

considerations. The expert steel maker may also discuss the correctness of the observation that steel obtained directly from a charge containing a much larger excess of ore than is possible in the ordinary open-hearth method possesses superior qualities to that manufactured in the usual way. The contention may be difficult to support *a priori;* but some empiricists are nevertheless convinced of its truth, and even when they admit the possibility of making good steel from any kind of raw material make inconvenient inquiries as to what it costs.

That it is possible to produce steel directly from iron ore in the electric furnace is well known. This has been done by various electrometallurgists, but the best published account of that work is by Major Stassano. According to his most recent publications (this journal, Vol. VI, No. 8, page 315) the best results obtained in the production of steel, where the charge consisted essentially of ore and carbon, showed an energy consumption of 4 kilowatt hours per kilogram, or 0.62 horse-power year per gross ton. The cost of lining the furnace, as calculated from a long series of experiments, amounted to $1.93 per ton (metric?) of output.

The experiments made with the electric furnace in the production of pig iron at Sault Ste. Marie, under the auspices of the Canadian Government, have shown the possibility of producing a ton of metal from a mixture of ore, carbon and fluxes with an expenditure of less than 0.28 horse-power year. Now it seems reasonable to suppose that if by using the Lash process in the electric furnace an energy consumption comparable with that of the electric iron furnace should be obtained, the fields of usefulness of the electric furnace in the metallurgy of iron and steel would be greatly extended.

One of the most serious difficulties experienced in all processes where the reduction of iron from the ore with the object of producing steel directly is aimed at, is the serious loss of iron which occurs so that the yield of metal is too small. So far, however, as the Lash process is concerned there was little reason to fear a difficulty of this kind, for in the preliminary experiments made at our laboratories on a small scale it was found that 98 per cent of the iron contained in the mixture could be easily obtained.

This may be readily seen when it is pointed out that in these experiments the metal and slag were carefully preserved and weighed, and that it was found that the total loss of metal in the slag only amounted from 0.3 to 0.6 per cent of the iron contained in the mixture put in the furnace. So far, therefore, as the electric furnace was concerned the chief point to be determined was the amount of energy required to obtain one ton of steel.

In order to investigate this matter, there was a choice of various furnaces, for it was decided that to get results of any value it was necessary to work on a scale which would produce steel in commercial quantities. The possible furnaces seemed to be those of Girod, Héroult, Keller, Rochling-Rodenhauser and Stassano. For various reasons it was decided to use a Héroult furnace, shown in Fig. 1.

With this plant there were manufactured about 50 tons of steel having various analyses, of which a few are given in the following table:

HEAT NO.	9	11	23	27
Carbon	0.10	0.08	0.92	0.22
Manganese	0.75	0.09	0.41	0.94
Phosphorus	0.015	0.015	0.038	0.033
Sulphur	0.070	0.007	0.026	0.056
Silicon	0.02	0.09	0.13	0.03

The following tests were made from bars 1 inch square hammered from 6 x 6 inch bottom cast ingots. The elongation was determined in a length of 2 inches:

Heat No.	Tensile Strength.	Elastic Limit.	Elongation per cent.	Reduction per cent.
9	57000	34000	33	58
27	77000	45000	28	56

The steel of heat No. 27 was treated with 0.1 per cent of titanium.

In all twenty-six runs were made, the methods of working the furnace being varied so as to investigate the working of the Lash process under as widely differing conditions as possible. Naturally such a method of experimenting was not conducive to the highest efficiency of working, but nevertheless it was possible to obtain complete reduction of the charge with an expenditure of 0.27 horse-power year per ton of steel, and turned out a finished product with an energy consumption of 0.33 horse-power year per gross ton of steel cast.

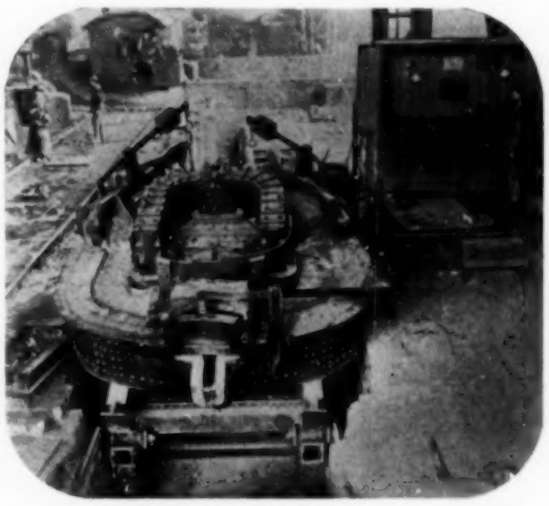


FIG. 2.—THREE-PHASE ROECHLING-RODENHAUSER FURNACE.

In all the experiments there was an excessive expenditure of energy in the process of finishing the steel, adjusting the carbon, removing phosphorus, etc. Making due allowances for the difficulties under which the experiments were carried out, such as inadequate apparatus, inexperienced workmen, variation of the method in every experiment, it is believed that under suitable conditions a production of 4 tons of steel per horse-power year can be reached.

Fig. 1 shows the furnace in process of pouring the steel into the ladle. The photograph was taken by Mr. J. R. Wilson, who did most of the construction work on the plant.

A serious problem met with in the working of the process in the Héroult furnace was the wear of the carbon electrodes, which in many runs was excessive. This was found to be due to various causes, but more especially to the inadequate apparatus for adjusting the electrodes and to certain faults in the method of working the furnace. Experiments made with a view of correcting the latter cause showed such an astonishing decrease in the electrode consumption that it is reasonable to believe that while the best results obtained in the experiments showed a consumption of 69 pounds per ton of steel cast, this may be brought below 50 pounds per ton.

Another very important consideration in the process is the wear of the lining, but unfortunately there have not been a sufficient number of runs made to obtain an accurate estimation as to what this item will amount to.

In carrying out the Lash process in the electric steel furnaces of Keller and Girod the conditions would be very similar to those met with in the Héroult furnace; but in the Stassano furnace the electrode problem would probably be much simpler since these are held some distance above the charge. Whether the consumption of energy would be as low as in the Héroult furnace is another question; but it seems certain that the cost of producing steel would be less were the Lash process used than when working with the simple direct method.

"While the electrode problem can, no doubt, be successfully solved, its existence emphasizes the interest of a furnace which can be worked without these troublesome and expensive appendages." The Colby-Kjellin induction furnace would obviously be unsuitable for use with this process, because it does not permit the handling of slags in a convenient and economical manner, but the modification of this apparatus, known as the Roechling-Rodenhauser furnace, might be expected to give interesting results. Fig. 2 shows a three-phase furnace of this kind, the three channels forming the secondaries of the induction furnace being connected to a central bath which is so constructed that the slag formed during the reduction of the ore can be handled. Moreover, this central bath would also permit of the easy introduction of the charge, which would probably be in the form of briquettes. (For further details of this furnace see our last issue, page 458.)

Mr. FitzGerald showed some excellent cold-bending tests of Lash-process steel; also one bent bar of steel which had been treated with 0.1 per cent of titanium in the ladle, with a curious fibrous structure resembling wrought iron.

In the discussion which followed Mr. Fitz-Gerald's paper Mr. Hy. D. Hibbard compared the electric furnace with ordinary metallurgical furnaces with their oxidizing atmosphere, like the open-hearth. In the open-hearth furnace oxygen is the active element. In the electric furnace we have the possibility of producing heat without oxidation. This is very important practically. The chief trouble with the electric furnace is the capital investment required. Mr. Hibbard also thought there was some similarity between the Lash process and the old Uchatius process.

Dr. J. W. Richards spoke of steel making by two different processes.

One is to melt the desired ingredients together, as in the crucible process, or in the simple induction furnace. The other evolves elimination of impurities. Both processes require different kinds of apparatus. The second requires essentially a large surface.

Prof. W. S. Landis thought the loss of iron in the slag would be serious. Mr. FitzGerald explained that in the first experiments with the Lash process in Niagara Falls considerable iron (up to 15 per cent in some cases) passed into the slag. This was diminished later to some 6 per cent. A reduction of the loss of iron in the slag accompanied the reduction of the power consumption. Dr. J. W. Richards thought the loss of iron in the slag was not serious. This loss is considerable in the open-hearth furnace. In the Monell process the loss is some 15 or 20 per cent, but the process is successful.

Dr. Richards thought that to make electric steel furnaces successful co-operation is necessary between the electrometallurgist, who knows all about the electric furnace, and the practical steel man, who knows all about steel making.

Mr. FitzGerald explained that the mixture used in the experiments at Niagara consisted of 60 per cent of iron ore, 23 per cent of cast iron (in form of borings or shotted pig iron), the balance being fluxes and carbon.

Vaporization of Zinc.

The following paper was presented by Mr. WOOLSEY MCA. JOHNSON, of Hartford, Conn., who, in studying the condensation of zinc vapor from all sides of the problem, scientific, commercial and practical, has calculated the latent heat of vaporization of zinc by use of thermodynamics as follows. This calculation was necessary, since the value has never been determined experimentally.

His calculations are based on the following formula, which is a direct consequence of the second principle of thermodynamics:

$$e = T \frac{dp}{dt} (v - v')$$

where e the latent heat of vaporization at 760 mm pressure, $v - v'$ the change of volume during vaporization, T the absolute temperature of the boiling point at 760 mm pressure, and $\frac{dp}{dt}$ the increase of pressure needed to keep zinc liquid for increase of temperature by 1° C. at the boiling point.

The boiling point of zinc at atmospheric pressure is 920° C., hence in the absolute temperature scale it is $T = 920 + 273 = 1193°$.

The value of $\frac{dp}{dt}$ at this temperature was found by Mr. Johnson to be 0.152 lb. per square inch increase of pressure per degree centigrade.

On the basis of these data the latent heat of vaporization of zinc becomes $e = 451$ calories per gram of zinc.

Barnes has also determined the value of $\frac{dp}{dt}$ (*Bull. U. S. Geol. Survey*, No. 54, March 10, 1889). On the basis of his results, Mr. Johnson's calculation gives a latent heat of vaporization $e = 388$.

Prof. J. W. Richards has estimated the latent heat of vaporization of zinc on the basis of Trouton's law and found it to be $e = 426$. It can, therefore, be assumed that the mean of 426, 451 and 388, or 422, is a figure close enough to the actual value for practical purposes.

In order to condense zinc practically on a large scale, it is necessary to study the physical chemistry of the problem and also to have due regard for the engineering and commercial side. The latter is, of course, the acid with which to test your theories.

Heat Conductance Through Walls of Furnaces.

Mr. CARL HERING, consulting engineer, of Philadelphia, presented a paper on the calculation of the heat conducted from the interior to the outside of a furnace through its walls.

In calculating the loss of heat through the walls, the cross-section of different parts of the path of the heat vary very greatly, as the walls have a small surface on the hot side and a large one on the outside. For all but large and relatively thin-walled furnaces this variation in cross-section is very great. To use the ordinary average cross-section, that is, the arithmetical mean, as is usually done, is not rigidly correct.

The purpose of Mr. Hering's paper is to give the rigidly correct results, to reduce important and useful relations from them, and to compare the correct results with those obtained from the approximate formulas in which the simple arithmetic mean is used. The error in using the approximate formula varies greatly, being sometimes negligible and at other times very large, amounting to several hundred per cent.

The well-known formula for calculating the conduction of heat through bodies is

$$H = \frac{S}{l} kt \qquad (1)$$

in which H represents the gram calories per second which pass through from one side to the opposite one, if no heat is lost on the way; S is the cross-section of the body in square centimeters; l its length in centimeters, k the conductivity found in tables which signifies the calories per second which will pass from one side of a cubic centimeter of the specific material to the other, for 1° C. difference of temperature, there being no loss of heat through the other four sides of the cube: t is the difference of temperature between the two faces, in Centigrade degrees.

Of all these quantities, S and l are purely geometric; that is, they are mere dimensions and have nothing to do with any physical constants, they are constant for a body of any given shape and are independent of the temperature, the material or any other such factors. Hence, they may be considered by themselves, and the relations between them will always be the same for all bodies of like size and shape. The present paper deals with this relation of S and l in such shaped bodies as constitute the walls of furnaces. The difficulty in determining the loss of heat through irregularly-shaped bodies, like frus-

trums, lies in this relation of S and l, and when this has been determined the rest of the calculation becomes very simple.

This quantity S/l in the above formula signifies the conductance of any particular body of a given shape and size, for a conductivity equal to unity. It might be called a conductance factor. When thus considered it can be calculated for a body of any particular shape, and then is that number which, when multiplied by the conductivity k, gives the total conductance of that body; and when this conductance is again multiplied by the difference of temperature, it gives the flow of heat through the body. In Mr. Hering's paper the true values of this

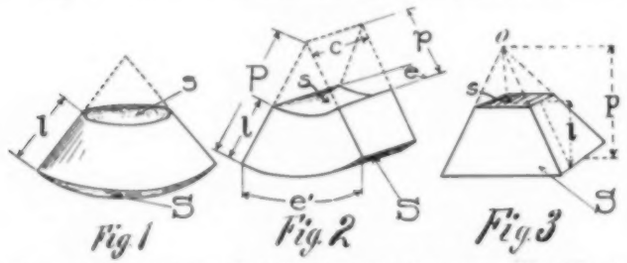


FIG. 1.—FRUSTRUM OF HOLLOW SPHERE. FIG. 2.—FRUSTRUM OF CYLINDER. FIG. 3.—FLAT FRUSTRUM.

conductance factor are calculated for numerous ranges of thickness in several typical cases.

It may be claimed that the value of k is so uncertain that there is no need of accuracy in the other factors of the formula. The errors in the usual way in which this conductance factor is calculated are, however, sometimes very great. Moreover, if there are several uncertain factors in a formula, the results will be more reliable the less the inaccuracies and uncertainties involved in it, and it is hoped that with the great need of more accurate values of k they will before long be forthcoming.

For the purposes of these deductions furnaces are best divided into three typical classes: spherical, cylindrical and cubical. Others must be considered to belong to the nearest typical form or calculated by themselves.

Fig. 1 shows a frustrum of a hollow sphere, Fig. 2 a wedge-shaped frustrum of a hollow cylinder, and Fig. 3 a flat frustrum, whose two parallel sides are perpendicular to its axis and whose cross-section varies proportionally with the square of the axial length from the center O; no other conditions are imposed and it may, therefore, have any shape of cross-section, round, rectangular or irregular. In all of them the resistance or conductance is understood to be that between the two parallel faces, the distance between them or thickness of the wall being represented by l. The smaller, or hot surface, is s, the larger, or cooler, S.

The calculation of heat conductance is, of course, directly analogous to the calculation of electric conductance. Mr. Hering bases his calculations on the following formulas from an unpublished work of Dr. E. F. Northrup for the electric resistance of these three typical forms of frustrums, namely, first, for a frustrum of a hollow sphere:

$$R = \frac{rl}{\sqrt{S\,s}} \qquad (2)$$

Second, for a whole cylindrical shell with open ends:

$$R = \frac{r}{2\pi c} \times \text{nat. log } \frac{P}{p} \qquad (3)$$

and, third, for a pyramidal frustrum as above defined,

$$R = \frac{r}{\sqrt{n}}\left(\frac{1}{\sqrt{s}} - \frac{1}{\sqrt{S}}\right) \qquad (4)$$

The correctness of these formulas, as given here, is assumed.

The corresponding approximate, but much simpler formula with which these are to be compared, in which the arithmetic mean is taken of the two surfaces S and s is

$$R = \frac{2r\,l}{S+s} \qquad (5)$$

In all of these R is the resistance in ohms between the two surfaces S and s stated in square centimeters, l is the length or normal distance between the two surfaces in centimeters, r is the resistivity in ohm-cubic-centimeter units, and in the case of the cylindrical one, P is the outer, p the inner radius in centimeters, and c the axial length of this cylinder in centimeters; n is the rate of flare in Fig. 3, such that $S = n P^2$, in which P is the perpendicular distance from the center O to the surface S. All these dimensional letters are shown in the diagrams.

In order to make direct comparisons, all these formulas must be reduced to the same terms; in practice the quantities which are always known are the surfaces S and s, and the distance between them, or thickness of wall, l; hence, the formulas should all be reduced to these common terms.

The formula for the cylinder is not in a form suitable for comparison with the others, as it is for the whole cylindrical shell and not for a portion of it. To reduce it to a fractional part of the circumference and to an expression which involves only the quantities S, s and l, like the others, let e be the circular length of the curved inner edge of the wedge-shaped cylindrical frustrum, as indicated in the diagram; then, the resistance of the frustrum will be

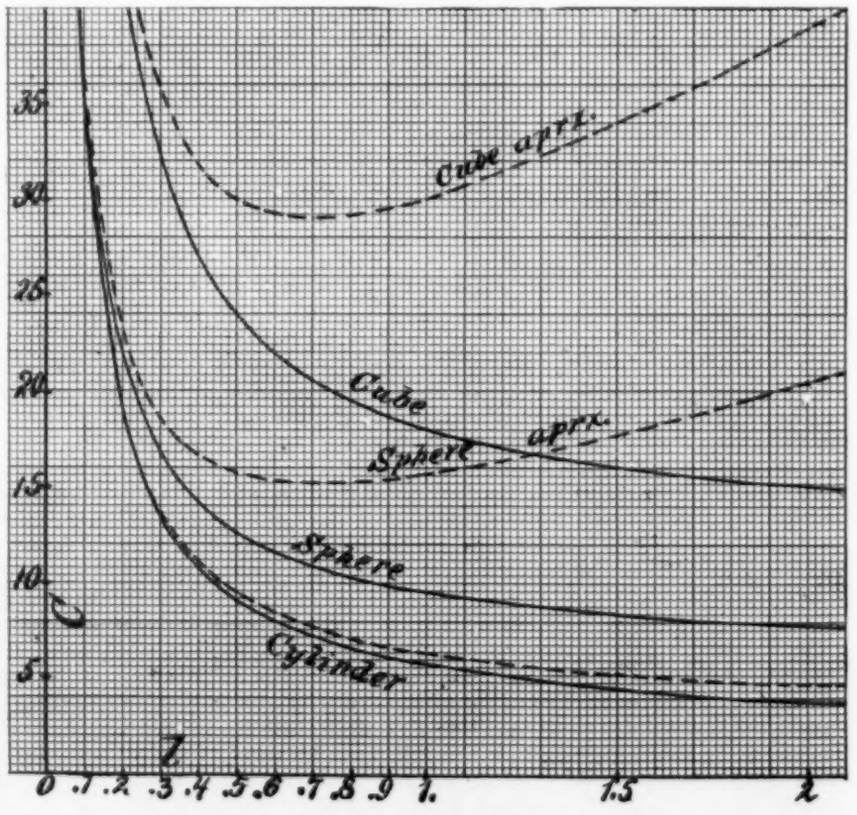


FIG. 4.—HEAT LOSS AS FUNCTION OF THICKNESS OF WALLS.

$$R = \frac{2\pi P}{e} \times \frac{r}{2\pi c} \times \text{nat. log } \frac{P}{p}.$$

By reducing this to the terms S, s and l (by substituting S/s for P/p, s for the surface $c\,e$, and for p its value $s\,l/(S-s)$ we get

$$R = \frac{r\,l}{S-s} \times \text{nat. log } \frac{S}{s} \qquad (6)$$

For the cubical frustrum, Fig. 3, $2\,l = \sqrt{B} - \sqrt{A}$, and $S = 4P^2$, hence $n = 4$, and after making some simple algebraic reductions, equation (4) becomes

$$R = \frac{r\,l}{\sqrt{S\,s}} \qquad (2)$$

which will be seen is the same as equation (2) above for a spherical frustrum. Hence, the comparison is reduced to only two forms, the spherical or cubical, and the cylindrical. It will be noticed that in the formula for the cubical and spherical frustrums the correct effective cross-section is the geometric mean between the two extremes.

All these formulas apply equally well to either frustrums or to the whole of a complete body.

As the natural or Naperian logarithms are not so convenient to use, especially for fractions which may be near to unity, formula (6) may be written

$$R = \frac{2.3026\,r\,l}{S-s} \times \text{com. log } \frac{S}{s} \qquad (7)$$

These formulas all apply equally well to heat resistance, if r is the heat resistivity; that is, the reciprocal of the heat conductivity stated in c.g.s. units (grams calories per second for 1 cu. cm and 1° C.), and R is the total heat resistance in the same units. Then, the heat passing through such a body in gram calories per second is, analogously to Ohms law,

$$H = \frac{t}{R} \qquad (8)$$

in which t is the difference of temperature between the two surfaces.

It must be clearly understood that formulas (1) and (8) and any deductions made from them, refer to the temperatures of the heat conductor at its two end surfaces and have no reference to the surface contact resistances between the heating or the cooling gases or liquids; these must, of course, be added if they are appreciable.

It must also be understood that the conductivity of most heat insulators varies with the temperature, sometimes very decidedly. In the formulas here given it is assumed that the conductivity is the mean for the particular range of temperature of any given case.

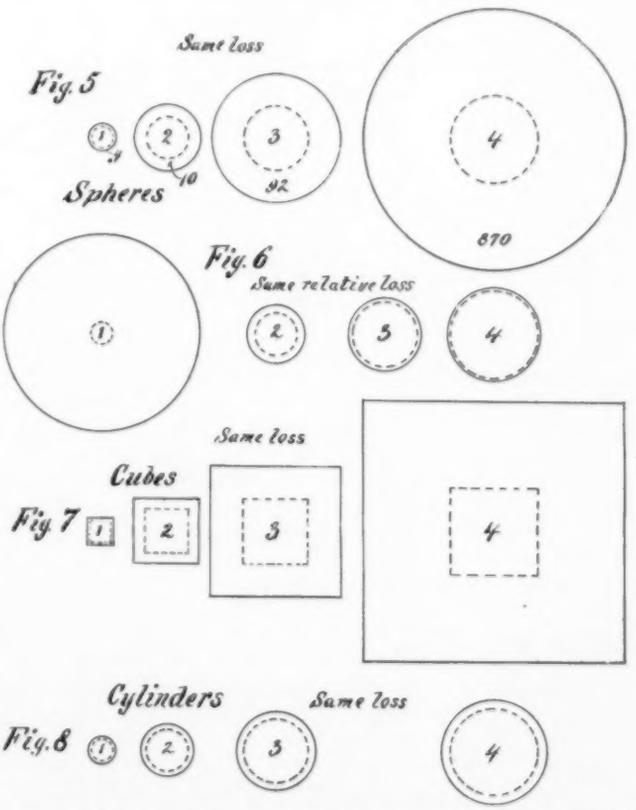
The present investigation, however, deals primarily only with the question of what shall be used as the mean or average cross-section in formula (1) for such frustrums, or as the result cannot be given in just that form, it deals with the part S/l in that formula, and, therefore, is not concerned with either the conductivity or the temperature. It deals with the conductance for a conductivity of unity.

In what follows conductances will be used instead of resistances, as the former are more generally used in calculations of heat; hence, the results apply to formula (1) rather than (8), although in the opinion of Mr. Hering, when the walls of furnaces are composite, it is much simpler to use resistances instead of conductances.*

Mr. Hering has calculated tables and drawn curves for the three typical forms, spheres, cubes and cylinders, both from the correct and the approximate formulas, and for the range of thickness likely to be used in practice. In general, and for the purpose of making comparisons and reducing the number of tables and curves, the inside diameter or edge in the rectangular furnace is made the unit of comparison, and the thickness of wall l is given in terms of this diameter; thus $l = 1$ means that the thickness is equal to the diameter. The thicknesses l in the curves must, therefore, be multiplied by the diameters in any particular case to reduce them to actual inches or centimeters. On account of limitations of space we reproduce here only Mr. Hering's curves, while for the complete tables the reader must be referred to the complete paper of Mr. Hering, to be published in the *Transactions* of the society. (Of course, the curves of Fig. 4 give exactly the same figures as Mr. Hering's tables, only in graphical form.)

The curves in Fig. 4 have been so drawn to scale that they show at a glance how the heat loss diminishes as the thickness of the walls increases. For diameter of unity, the ordinates are numerically equal to the conductances for a conductivity of unity, that is, they are the numerical values of S/l in formula (1); they are, therefore, proportional to the heat losses and need only to be multiplied by the conductivity k, and the temperature drop t, and sometimes by the diameter also, for any given case to give the actual heat loss.

The distances to the right of the point O represent the thicknesses l of the surrounding walls in terms of the diameter or of the edge of the cube. Thus it will be seen that for thin walls the heat loss diminishes very rapidly as the thickness increases, but for the thicker ones the decrease of the loss becomes very small; hence a point is reached where it would be of little value to still further increase the thickness.



FIGS. 5, 6, 7 AND 8.—COMPARATIVE DRAWINGS, SHOWING SAME ACTUAL LOSS AND SAME RELATIVE LOSS.

The reason for this is that the real mean cross-section increases very fast for thicker walls, almost as fast as the thickness, and hence the quotient between them, namely, the factor S/l in (1), changes but very little.

Incidentally, Mr. Hering remarked here that there are two possible ways of still further decreasing this loss of heat through the walls which are the diametrical opposites of each other. One is to diminish the temperature drop t, say, by heating the outside of the furnace with cheap fuel heat, as, for instance, by placing the electric furnace inside of a gas or fuel furnace. From formula (1) it is evident that, all other things

*Concerning this point, we hope to publish an article by Mr. Hering in our next issue.—EDITOR.

being the same, the loss is less the smaller the drop of temperature t. The other method is to increase the temperature drop t, say, by water cooling the outside. Both methods have been used with apparent success. The explanation of this apparent anomaly undoubtedly lies in the value of the conductivity k. When the outside shell is cooled to a low temperature, the value k for that layer decreases and apparently more rapidly than t increases, hence their product in (1) becomes less. To determine which of these two diametrically opposite methods is the best in any particular case is a simple engineering calculation, provided the conductivity is known for that particular range of temperature. It is then merely a question of whether the product of k and t in (1) become less or greater.

The curves, Fig. 4, also enable one to find directly the value of the thickness l for any given loss, which if calculated would be quite a tedious operation for cylindrical walls, as it involves the equation $ax \log bx = c$.

The spherical type is the theoretically best form as it has the smallest cross-section of the insulator (normally to the radius) for a given interior volume. All other forms are worse; the cylinder comes next, and the rectangular, which is perhaps the most common, is the worst.

In the curves of Fig. 4 the full line represents the correct results, and the dotted line those obtained from the approximate formula. The latter, it will be seen, differs little from the true curve for small thicknesses, not used in practice, but departs very greatly from it for the more usual range of thicknesses; it even has a minimum point for a thickness equal to about three-fourths of the diameter, beyond which the loss would increase again for greater thicknesses, which, of course, cannot be correct.

In general, the loss calculated from the approximate formulas is the greater of the two, and, hence, the calculation is on the safe side. This appears to be borne out in practice in which the actual losses were found to be smaller than those calculated with this approximate formula. But the difference seems too great to be overlooked in electrical furnaces, in many of which the predetermined results are a criterion as to whether the actual construction shall be undertaken or not. In a recent case in Mr. Hering's practice the entire function of an electrical furnace was to maintain the material at a given temperature and not to do any melting or heating; hence, the amount of loss through the walls was the only heat to be supplied electrically and its correct predetermination was, therefore, of great importance. The curves of Fig. 4 show that beyond a thickness equal to a little less than the diameter, there is little to be gained.

Fig. 5 shows how very important it is to reduce the inside of a furnace to the smallest possible size to hold the necessary amount of material. It shows what the thickness of the walls of a spherical furnace must be when the inside diameter is doubled, trebled and quadrupled, and *when the actual loss is the same*. The increase will be seen to be surprisingly great. The volumes of the insulating material are given and will be seen to increase very rapidly, being about 2500 times as great for the largest one as compared with the smallest one. If these four hollow spheres were made of an electrical conductor, the resistance from the inside to the outside would be the same in all of them.

These diagrams, Fig. 5, are for an equal loss and merely show the great importance of not wasting any room in the inside, be the furnace a large one or a small one; they do not mean that furnaces should not be made large. The volumes of the interiors of these increase as the cubes of the diameters and, hence, are as 1 to 8 to 27 to 64. For the same relative loss, considering the increased interior capacity, that is, for the same loss per unit volume, the thicknesses will be as shown in Fig. 6. It will be seen that in this case the thickness becomes very great for the smaller ones and very small for the larger ones, becoming nearly constant. The volume of the insulation for the smaller ones is even far greater than for the larger ones.

This shows in an equally striking way the very great importance of using as large a furnace as possible; that is, it shows that the loss of heat per cubic foot interior capacity can be made very much less for a large furnace than for a small one, which means that the heat efficiency can be made much higher for the larger ones. The earth, considered as a molten mass surrounded by a solid shell, is a good illustration of this case, a relatively thin shell being sufficient to insulate it very effectively. The explanation is that the volume of the inside increases very rapidly with an increase of the diameter, hence the loss per unit volume becomes small. But it must not be forgotten that, as Fig. 5 shows, it is very important not to waste any space in it.

It can also be shown from these data that for the same relative thickness the loss in spherical furnaces increases as the diameter. That is, if the thicknesses in all of several furnaces are, say, three-fourths of the diameter, the losses will increase as the diameters; but as the cubical contents of the inside increase as the cube of the diameters, the loss per cubic foot of interior space, that is, per unit capacity, will diminish rapidly as the furnaces become larger.

To illustrate the use of the curve of Fig. 4 for the sphere by an example, let the inside diameter of a spherical furnace be 15 in.; let the thickness of the walls be 9 in.; required: the heat conductance for a conductivity of unity. The relative thickness l/d will be $9/15 = 0.6$, that is, the thickness is 0.6 of the diameter. From the curve the correct conductance corresponding to this value is 11.5; multiplying this by the diameter 15 gives 172.5 in inch units.

If this material is, say, infusorial earth, having a conductivity in gram-calorie, cubic-inch units, of $k = 0.001$, and if the fall of temperature between the inside and the outside is 700° C., then, according to formula (1), the heat loss through it will be

$$H = 172.5 \times 0.001 \times 700 = 121 \text{ gram-calories per second.}$$

Suppose the loss is limited in the above case to 100 calories per second and it is desired to find the necessary thickness of this material to make it so. The corresponding conductance from (1) must be $100/.001 \times 700 = 143$. Divide this by the diameter 15, giving 8.5. From the curve, Fig. 4, for this value of C that of l is about 0.98, hence the required thickness will be 0.98 time the diameter 15, or 14.7 in.

The curves for the cubical furnace show that the conductances (and, therefore, the heat losses) will be 1.910 times, or about twice, as great as those of the spherical form, for the same thicknesses and the same diameter or edge, but it must be remembered that the contents of a cube is nearly double that of its inscribed sphere, hence the difference is not what it seems at first sight.

Comparing a sphere with a cube whose edge is equal to the diameter of the sphere, both having the same thickness of walls, it will be found that the loss per unit of volume is the same in both. Hence, in this sense the cubical form is no worse than the spherical. A sphere and its circumscribed cube have the same surface per unit volume. But a cubical furnace whose inside volume is equal to that of a given spherical one will have an edge which is less than the diameter of the sphere; hence, for the same relative thickness of walls (l/d) the loss will be considerably greater for the cubical furnace; its conducting surfaces will be greater. It follows, therefore, that for a given interior volume, and the same relative thickness of walls, a spherical furnace is more economical in heat loss than a cubical one.

For equal losses, Fig. 7 shows the rapid rate at which the necessary insulation increases; these figures correspond with those of Fig. 5 for the sphere, and the wall thicknesses are the same.

For the same relative loss, that is, for the same loss per cubical contents, the results, corresponding with those shown in Fig. 6 for the sphere.

For the same relative thickness the losses are proportional to the length of the edge, like with the spherical form.

Lastly, the curves for the cylindrical furnace in Fig. 4 are not directly comparable with the others, because they are only for one unit length of a supposedly infinitely long cylinder, and only for the cylindrical part. They must be multiplied by the length of the cylindrical part and the heat loss at the two ends must be added. Even then there is a slight error at the circular corners, as the results in these tables refer only to a cylinder whose outside and inside axial lengths are the same as shown in Fig. 2. They are, therefore, strictly applicable only to long cylinders and do not include the flat ends. They are correct, however, for comparing different cylinders with each other.

The dotted and full curves of Fig. 4 show that the approximate formula is much more nearly correct in this case, and it has the same general character. Not only are the actual differences less, but the percentage differences are also less. Up to a thickness equal to the diameter, the errors in using the approximate formula are within 10 per cent.

That the loss is the same for any given relative thickness, l/d, is well shown in Fig. 8, which corresponds with Figs. 5 and 7, and in which the thickness merely increases with the diameter. These, however, should not be compared directly with those in Figs. 5 and 7, because they are only for one unit of length; the smaller one, therefore, is a cylinder whose length is equal to its diameter, a so-called square cylinder, because both are unity; while the largest one is four units in diameter, but only one unit long, and represents, therefore, a mere flat ring.

In the comparisons shown graphically in Figs. 5, 6 and 7, it should be remembered that a thick wall must be increased very greatly to make it appreciably better; hence, those shown with very thick walls would be very nearly as good with a greatly diminished thickness, and should, therefore, be considered as extreme cases cited to illustrate the laws, and not as giving the best proportions to be used in practice. Instead of using such extremely thick walls, one would naturally sacrifice a greater loss of heat.

[Since the paper was presented Mr. Hering has noticed the following simplification of the correct formula for the spherical and the cubical types, which avoids the square root calculations. For complete spheres the outside and inside surfaces S and s may be replaced by their values in terms of the respective diameters, D and d, the larger one, D, being equal to $d + 2l$ and is therefore easily measured or calculated. It can then be shown that the quantity $\sqrt{Ss}$ is equal to πDd, hence the correct formula becomes simply

$$C = \frac{\pi Dd}{l} \qquad (12)$$

which is as simple as could be desired. Similarly for a cubical furnace the correct formula can be reduced to

$$C = \frac{6Dd}{l} \qquad (13)$$

in which D is the outside edge and is equal to $d + 2l$. For any one side it would, of course, be 1/6 of this or

$$C = \frac{Dd}{l} \qquad (14)$$

which therefore is the correct formula for such frustrums as constitute the sides of a cube.]

Mr. Hering's paper elicited quite an extended discussion. Mr. Bennie spoke of the possibility of raising the efficiency of an electric furnace by surrounding it with a gas envelope in order to reduce the heat loss from the inside of the furnace to the outside; this is practical because heat generated from gas is cheaper than heat generated electrically. Dr. Richards pointed out that the greatest need now is to determine such constants as heat conductivity, etc. Prof. Landis referred to the valuable old determinations of Peclet which appear to be almost forgotten now. Messrs. Carrier, Hibard, Lidbury and Parker also spoke.

Intermittent Electrochemical Load for Central Stations.

The last subject on the program was a general discussion on the possibility of using electrochemical processes at times of low load of central stations, so as to equalize the load curve.

The subject was introduced by some informal remarks of Mr. ELMER A. SPERRY, of New York City. In a recent conference between central-station men and electrochemists he had noted what appeared to him like an undertone of disappointment on the part of the central-station proprietors as to the price they can get for power for electrochemical and metallurgical work. Mr. Sperry referred to a large 50,000-hp electrochemical works (a calcium cyanamide plant) now being erected at Niagara Falls, and claimed that power in large quantities can now be bought on the Canadian side of Niagara for $12 per horse-power-year, and perhaps even less, down to $10. That there is a practical possibility of combining electrochemical work with an ordinary central-station load is proven by a certain plant in Maine which has now been successful for about three years. What is needed are intermittent electrochemical processes, and Mr. Sperry referred to a recent chlorate process which is essentially intermittent. Progress in this whole field is possible only by continual agitation. Electrochemists should acquire the habit of thinking about intermittent processes while central-station men should consider what they can do in the line of price.

While Mr. Sperry represented the electrochemical engineers, the next paper, by Mr. JOHN MEYER, of the Philadelphia Edison Company, represented the central-station side of the question. In the absence of Mr. Meyer it was read by Mr. Graves, of the Brooklyn Edison Co.

Mr. Meyer pointed out that the tendency of the times is in the direction of specializing. Special effort in any one direction results in approaching closely to perfection in any development. This is no less true in the electrochemical and the central-station industry than in other lines of business. If it were possible to eliminate from any process all of the factors incidental to the production, such as, for instance, the supply of current, then it is fair to assume that the maximum effort could be applied to the actual process. All things being equal, there is then every incentive for co-operation between the electrochemist and the central station even to the extent of the location of the electrochemical plant with reference to the central station and hours of use of the current.

With the rapidly increasing demand in this country for many electrochemical products, as is evidenced by the importations of some of them, it would appear important, if not absolutely essential, to develop such industries here and to encourage relations between the central station and such industries at this time.

This is particularly true in the matter of development, wherein the one hindrance is the large immediate investment in order that the experiment may be conducted. Considering then that the experimental load can be so adjusted as to fill valleys which exist consequent to the conditions of the central-station load, there is then the possibility of obtaining a low rate depending upon local conditions which, however, would be mutually satisfactory to both parties concerned and which would help to develop the industry.

As a matter of fact, the majority of the industries *started* under circumstances where the service supply of the central station could have been used to advantage.

The maximum possible output of any plant *cannot* be maintained continuously. The actual output is a certain percentage of the maximum and may be considered as the average. The ratio between the maximum and the average may be expressed in terms of load factor as illustrated in the following example: If a plant having a maximum capacity of 100 units per day, and the average represents 60 units, then the load factor may be represented as 60 per cent, indicating that the average output was 60 per cent of the maximum possible. If the current

required to perform this operation is in direct proportion to the output of the product, then in the example stated above it is fair to say that, although the maximum may be required at intervals, the average load will only represent 60 per cent of this maximum. Applying this principle to the rate of $30 per horse-power per annum of the capacity, because of the average load being but 60 per cent of this capacity, the cost of current becomes actually $50 per horse-power per annum.

This question of load factor is one of importance and has not been fully appreciated by the electrochemical industries. The actual load factor of electrometallurgical plants in France varies from 50 per cent to 60 per cent based upon a 24-hour 365-day year. In other words the cost per horse-power is not the actual cost divided by 365 times 24, but it is a figure which is obtained by multiplying the equivalent 8760 hours by the load factor in percentage and this resulting figure divided into the annual cost per horse-power will produce the actual cost per horse-power-hour.

Mr. Meyer then pointed out that the matter of location of an electrochemical plant is materially affected by facilities for obtaining the raw material or of the disposal of the finished product. For instance, the ideal location of a plant, other things considered equal, would be such that the raw material may be obtained from the immediate neighborhood of the plant and the finished by-products disposed of also near to the plant. "In a recent investigation of contemplated electric furnace plant the central station offered reasonably low rates for an experimental plant of small capacity, holding out as an inducement, which has been admitted to be equitable, a reasonably lower rate in the event of the furnaces proving satisfactory, and the furnace capacity increased to such an extent as to eliminate all of the oil furnaces now in use. There is every evidence that if this particular installation proves satisfactory a great many similar furnaces will be installed in various industries.

"In another instance a small arc furnace having a capacity of 20 kw has been installed for the purpose of demonstrating the production of nitrogen compound with the electric furnace. The current for the operation of this furnace is purchased from the central station. Upon completion of this demonstration a series of furnaces of considerably larger capacity will be installed."

Mr. Meyer finally referred to such electric furnace processes which, like the carborundum process, work necessarily intermittently. Such processes would be ideal for operation from central stations. Industries of such kind should locate chiefly at such points where any by-products could be utilized and easily sold. Such considerations may be more important than the cost of power.

The two papers of Mr. Sperry and Mr. Meyer elicited an extended and at times quite animated discussion. While hardly any tangible result was reached, the discussion certainly helped to clear the views on the subject.

It was opened by President Acheson, who explained that the carborundum process, as carried out at Niagara Falls, required 36 hours, so that it would not directly fit the requirements of central-station load. But if a plant used two furnaces, one being started 24 hours after the other, then it could always be so arranged that at times of peak load of the central station only one furnace would be working.

Mr. Edward R. Taylor said that his own carbon bisulphide furnace could be worked intermittently, but not as well as continuously. It would not do to shut the current off continuously, but it might be reduced to such an extent as to maintain the temperature in the furnace without furnishing any energy for the chemical reaction. Of course, this would be uneconomical to a certain extent.

Mr. Carl Hering pointed out that for the reasons just given by Mr. Taylor, it is very important to know the loss of heat through the furnace walls of an electric furnace, since this loss represents the electric energy which must be supplied to the furnace at the non-working period, as sketched by Mr. Taylor.

Mr. W. F. Wells, of the Brooklyn Edison Co., thought that arrangements were quite possible by which current could be furnished from the central station to electrochemical works continuously during the greater portion of the year; during another portion of the year current could be furnished continuously except on Saturday nights; and during another very short period, which would be not more than a month and a half, current could be furnished continuously, with the exception of a one-hour peak. It is a fact that 25 per cent of the capacity of a large number of central stations is used only during 100 hours per year. To find a use for these 25 per cent of capacity during the balance of more than 8,000 hours would be very important.

Mr. Lawrence Addicks thought that to buy current from a central station would not be attractive to the copper refiners, since they are able to produce very cheap power themselves with their excellent load factor. Moreover, the copper refining process is exceedingly sensitive with respect to changes of conditions.

Mr. C. F. Carrier, Jr., had figured out a scheme for an electrolytic sodium plant, but found that when he would get the power cheap enough for his purpose the central station would make no money, and that on the other hand he could make no profit with the sodium if the central stations made money with their power. It seemed that the only possibility of combining profitably electrochemical work with central-station load would be for the central stations to undertake the electrochemical work themselves.

Mr. F. A. J. FitzGerald had made tests with an induction furnace to find the amount of power required to simply keep the temperature of the steel constant without working. This was not less than one-third the normal power of operation.

Mr. Hy. D. Hibbard thought that the central stations should endeavor to extend the use of electricity for simple power purposes, like grinding, in chemical and metallurgical works.

Mr. C. A. Graves, of the Brooklyn Edison Co., explained that electric central stations now supply power for refrigerating purposes. He also emphasized the great reliability of electricity supply from large central stations; they are quite willing to make contracts involving large payments of damages in case of failure of supply even for minutes only.

Mr. J. M. Kebbe, of the Brooklyn Edison Co., emphasized that in many cases the greater cheapness of water-power may be more than counterbalanced by the better shipping facilities, the nearer market, the cheaper labor, etc., usually found near large central stations. He and Dr. Richards referred to the successful working of the Girod steel furnace in a Swiss city, where energy is bought from the central station at a reduced rate (see page 452 of our November issue).

Mr. G Breed, of Philadelphia, referred to the conditions of some power plants outside of New York State. Mr. Kohn asked for exact figures of rates. The fixation of rates by Public Service Commissions was also referred to.

Mr. Bennie said the power companies of Niagara Falls had paid the greatest attention to the subject of power factor and had found no solution. Mr. Addicks thought that the importance of the power cost is sometimes overrated; in copper refining it is from 20 to 25 per cent of the total cost; and a little saving in power may easily be outbalanced by other factors.

Dr. Richards thought there was certainly a field for the use of electric power from central stations for the operation of relatively small electric furnaces intermittently in brass and steel foundries and for the simple melting of metals.

Mr. Edward R. Taylor, who represents the Society on the Commission for the Conservation of Our Natural Resources, then gave an outline of the work of this commission.

On motion of Mr. Hering a vote of thanks was tendered to all who had made the meeting successful. Adjournment followed.

The attendance was beyond 200. In the following we give an alphabetical list of those names contained in the last printed registry list:

Edward G. Acheson, Niagara Falls, N. Y.; Charles E. Acker, New York City; Lawrence Addicks, Elizabeth, N. J.; Mr. and Mrs. W. A. Arison, Niagara Falls, N. Y.; L. Baekeland, Yonkers, N. Y.; W. D. Bancroft, Ithaca, N. Y.; Harry Barker, New York City; Walker Bowman, New York City; Charles E. Bradley, New York City; F. E. Breithut, New York City; A. A. Breneman, New York City; C. F. Burgess, Madison, Wis.; C. F. Carrier, Jr., Carteret, N. J.; H. R. Carveth, Niagara Falls, N. Y.; Charles F. Chandler, New York City; H. B. Coho, New York City; Edward A. Colby, Newark, N. J.; F. D. Crane, New York City; J. S. Crider, Cleveland, Ohio; E. B. Crocker, New York City; Mrs. C. H. Cromwell, Savannah, Ga.; T. S. Crossman, New York City; R. W. Curtis, New York City; Allerton L. Cushman, Washington, D. C.; Zoltan de Havath, New York City; William Dreyfus, New York City; C. A. Doremus, New York City; G. Drobegg, Brooklyn, N. Y.; Orrin E. Dunlap, Niagara Falls, N. Y.; E. Durant, New York City; Thomas A. Edison, Orange, N. J.; A. H. Elliott, New York City; W. E. Estabrooke, New York City; Irwin H. Fenn, New York City; Mr. and Mrs. John H. Finley, New York City; L. H. Friedburg, New York City; R. H. Gaines, New York City; A. E. Gibbs, Wyandotte, Mich.; C. P. Goepel, New York City; J. H. Goodwin, East Orange, N. J.; W. L. Goodwin, Kingston, Ont., Can.; Mr. and Mrs. C. A. Graves, Brooklyn, N. Y.; H. C. Griffin, New York City; Morton L. Griffin, Springfield, Mass.; L. F. Guttman, New York City; Charles M. Hall, Niagara Falls, N. Y.; W. J. Hammer, New York City; W. A. Hamor, New York City; J. L. Harper, Niagara Falls, N. J.; Jacob Hasslacher, New York City; Carl Hering, Philadelphia, Pa.; Henry D. Hibbard, Plainfield, N. J.; J. F. Hinckler, Brooklyn, N. Y.; B. H. Hite, Morgantown, W. Va.; Walter E. Holland, Orange, N. J.; Mr. and Mrs. Henry Howard, Brookline, Mass.; W. S. Howell, New York City; George A. Hulett, Princeton, N. J.; Walter R. Ingalls, New York City; Woolsey McA. Johnson, Hartford, Conn.; Mr. and Mrs. G. M. Kebbe, Brooklyn, N. Y.; A. A. Knudson, New York City; A. B. Lamb, New York City; C. LeBoutillier, New York City; Wallace G. Levison, Brooklyn, N. Y.; F. A. Lidbury, Niagara Falls, N. Y.; A. T. Lincoln, Troy, N. Y.; C. F. Lindsay, Schenectady, N. Y.; Carl H. Lips, Brooklyn, N. Y.; Morris Loeb, New York City; A. C. Lundey, New York City; A. F. Madden, Newark, N. J.; C. O. Mailloux, New York City; W. McMurtrie, New York City; Mr. and Mrs. H. R. Moody, New York City; G. W. Morden, Toronto, Can.; L. P. Morgan, Philadelphia, Pa.; Paul F. Mottelay, New York City; Charles W. Moulton, Poughkeepsie, N. Y.; W. H. Nichols, New York City; Nathaniel Nodell, New York City; William L. Nodell, New York City; R. J. Nunn, Savannah, Ga.; Thomas F. O'Keefe, New York City; John C. Parker, Rochester, N. Y.; H. E. Patten, Washington, D. C.; H. Philipp, Perth Amboy, N. J.; W. H. Prager, New York City; B. E. F. Rhodin, Sault Ste. Marie, Can.; J. W. Richards, So. Bethlehem, Pa.; I. L. Roberts, Lockport, N. Y.; E. F. Roeber, New York City; A. J. Rossi, New York City; S. S. Sadtler, Philadelphia, Pa.; S. E. Saunders, Niagara Falls, N. Y.; G. P. Scholl, New York City; F. F. Schuetz, New York City; C. H. Sharp, New York City; William Acheson Smith, Niagara Falls, N. Y.; J. Lorenz Sporer, New York City; Miss L. Statham, Mechanicsville, N. Y.; Noel Statham, Mechanicsville, N. Y.; R. Stevenson, New York City; C. C. Stirling, Hartford, Conn.; Walter T. Taggert, Philadelphia, Pa.; Mr. and Mrs. E. R. Taylor, Penn Yan, N. Y.; Charles E. Taylor, New York City; J. E. Teekle, New York City; B. F. Thomas, Chattanooga, Tenn.; Maximilian Toch, New York City; F. J. Tone, Niagara Falls, N. Y.; Mr. and Mrs. C. P. Townsend, Washington, D. C.; S. A. Tucker, New York City; F. W. Varley, New York City; L. D. Vorce, Detroit, Mich.; R. von Foregger, New York City; Mr. and Mrs. Alois von Isakovics, Monticello, N. Y.; W. H. Walker, Boston, Mass.; W. D. Weaver, New York City; Utley Wedge, Philadelphia, Pa.; W. F. Wells, Brooklyn, N. Y.; E. Weston, Newark, N. J.; W. A. Whitaker, New York City; Mr. and Mrs. Jasper Whiting, Boston, Mass.; F. G. Wiechman, Brooklyn, N. Y.; H. W. Wiley, Washington, D. C.; H. Wohlwill, Hamburg, Germany; J. A. Yunck, South Orange, N. J.; F. Zimmerman, Newark, N. J.

The Promotion of Science the True Means to the Re-establishment of National Prosperity.

BY CHARLES A. DOREMUS, M.D., PH.D.

The closing years of the eighteenth century witnessed our people endeavoring to reap the fruits of their struggle for independence in building up the new nation which they had founded. War continued to devastate Europe, and it was difficult to foresee which nation would in the end hold the supremacy. It was during this trying period at the beginning of the nineteenth century that Sir Humphrey Davy, in a public lecture, called attention to the cultivation of the sciences as follows:

"Science, for its progression, requires patronage; but it must be a patronage bestowed, a patronage received with dignity. It must be preserved independent. It can bear no fetters; not even the fetters of gold, and, least of all, those fetters in which ignorance or selfishness may attempt to shackle it.

"And there is no country which ought so much to glory in its progress, which is so much interested in its success, as this happy island. Science has been a prime cause of creating for us the inexhaustible wealth of manufactures, and it is by science that it must be preserved and extended. We are interested as a commercial people. We are interested as a free people. The age of glory of a nation is likewise the age of its security. The same dignified feeling which urges men to endeavor to gain a dominion over nature will preserve them from the humiliation of slavery. Natural, and moral, and religious knowledge are of one family; and happy is that country, and great its strength, where they dwell together in union."

We have been passing, not through a period of war, but a period of national distrust and depression and are emerging freed from many entanglements which have threatened the body politic. In the midst of this distrust of the future our attention has been called to the vast natural resources which abound on all sides. But we have also been warned of the wasteful misuse of these, and a call has gone forth from the chief of the nation which has resulted in the formation of a National Conservation Commission, whose duty it shall be to secure the wisest utilization of our wealth, with due regard to our posterity. While the national government instigated this movement, the States have now individually given their hearty approval and co-operation.

While the nations of Europe long ago appreciated the importance of chemistry as the basis of their pursuit of either agriculture or of manufactures, we have been tardy in recognizing our needs in this direction. It is only within the past quarter of a century that our universities and technical schools have been equipped with adequate laboratories where chemistry and the sister science physics could be studied as they should be. Not until the progress in electricity created a demand for instruction, which our institutions could not ignore, did we awake to the necessity of providing our young men the educational advantages needful to their life work.

Our national chemical society, founded in 1876, had in its first years a precarious existence. It required the most patient and persistent labor of its organizers to carry it through to the wide influence which it is now exerting and which it is now further extending by developing still wider fields of usefulness.

We have been forgetful of our opportunities, of the solid foundations upon which this nation was builded, of the virility of the men who took upon themselves the task of conquering nature in a wilderness.

In their foresight they founded the Philadelphia Chemical Society in the year 1792. It was the first society of its kind in the world. Priestley was a member. It was the custom that there should be an annual oration. Such a one was delivered before the society and ordered published on April 11, 1798. Mr. Thomas B. Smith chose as his title "A Sketch of the Revolutions in Chemistry." His peroration is so permeated with inspiring thoughts, which apply so well to our present needs, sound such an optimistic bugle call, that we venture to quote the closing paragraphs, that we be reminded of our birthright:

"Living as we do in a new, extensive and unexplored country, separated by an immense ocean from all other civilized nations, we must feel ourselves deeply interested in a knowledge of its mineral productions and this can only be arrived at through the medium of chemistry. As far as our very limited knowledge has yet gone, we have every reason to believe that Nature has been far from bestowing her blessings with a parsimonious hand. Abounding as it does with the richest ores of the most valuable metals, we should be committing a crime of the blackest dye were we through *wilful ignorance* to trample under our feet these invaluable gifts of the Creator.

"The only true basis on which the independence of our country can rest are agriculture and manufactures. To the promotion of these nothing tends in a higher degree than chemistry. It is this science which teaches man how to correct the bad qualities of the land he cultivates by a proper application of the various species of manure, and it is by means of a knowledge of this science that he is enabled to pursue the metals through all the various forms they are put on in the earth, separate them from substances which render them useless, and at length manufacture them into the various forms for use and ornament in which we see them. If such are the effects of chemistry, how much should the wish for its promotion be

excited in the breast of every American! It is to a general diffusion of a knowledge of this science, next to the virtue of our countrymen, that we are to look for the firm establishment of our independence. And may your endeavors, gentlemen, in this cause entitle you to the gratitude of your fellow citizens."

Transportations of Liquids.

By Oskar Nagel, Ph.D.

For the transportation of liquids a large number of appliances, such as injectors, syphons, eductors, air-jet lifts, montejus pumps, etc., are on the market. According to the nature of the liquid handled, these apparatus are made of iron, copper, lead, bronze, hard rubber or stoneware. Enamel is frequently used as coating.

Acid-proof cast iron may be made according to the following analysis:

	A. DARK GRAY.	B. LIGHT GRAY.	C. MIXED.
Silicon	3.5	1.5	0.7
Manganese	0.5	0.4	0.2 to 0.3
Phosphorus	0.2	0.2	0.2
Total carbon	3.8	3.5	3.5

All three brands, A, B, C, should be free from sulphur. To get the best results, A, B and C should be mixed in the proportions of 2:1:1.

Injectors.—The Koerting universal double-tube injector,

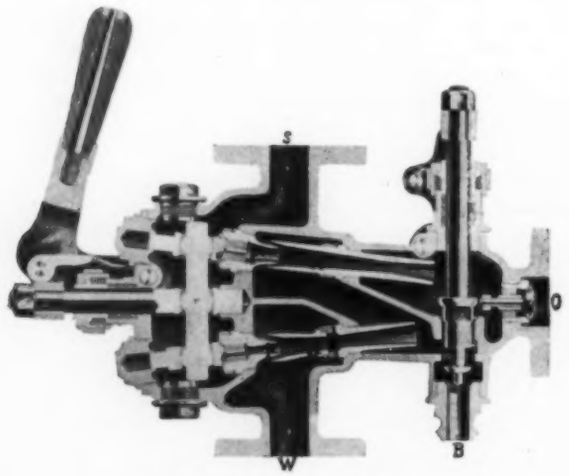


FIG. 1.—INJECTOR.

shown in Fig. 1, is extensively used for transporting water to the boiler.

B is the discharge; N the lower water nut; N_1 the upper water nut; O the overflow valve; P the lower steam nozzle; P_1 the upper steam nozzle; S the steam supply; W the suction.

This injector is a combination of two jets. The lower jet is proportioned for extreme temperatures, and for quick and strong action, which includes maximum high suction. The discharge is into the upper jet where the water receives the additional strong impulse to carry it into the boiler. The pressure and volume from the lower jet corresponds to the steam pressure, and this is as it should be to answer the requirements of the upper or forcing jet. The varying volume insures the proper working at high steam pressure, as well as at low, and increased pressure admits increased high temperature.

Universal Syphons or Steam Jet Pumps.—These apparatus are used for moving water or other liquids, where durability, low cost and simplicity of manipulation are of importance or where an increase of temperature is beneficial. They are made of brass or iron, with brass nozzles.

These syphons are advantageously used for lifting bleaching liquor, milk of lime, water, pulp, sugar juice, molasses, chemicals, etc. The extreme simplicity of the apparatus and certainty of operation at all times are evident advantages. In most applications where it is necessary to heat the liquid the cost of elevating the liquid may be considered to be almost nothing.

Stoppages in suction pipes, strainer or in the apparatus are

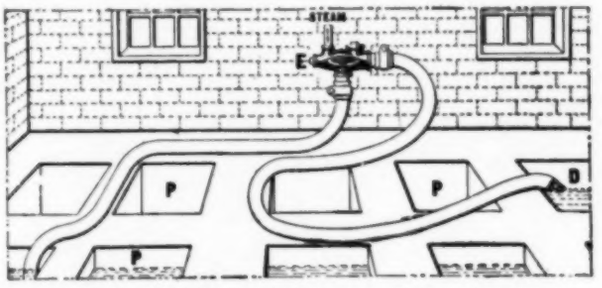


FIG. 2.—SYPHON FOR TRANSFERRING LIQUID FROM PITS.

promptly cleared by providing a shut-off in the discharge pipe, which when closed will cause the steam to blow back and clear the obstruction.

Fig. 2 shows an application of these syphons for transferring liquids from pits, in tanneries or chemical works. D is the discharge, E the syphon and P the pits.

The most extended application of syphons is found in such chemical industries where the liquids need not only to be elevated and moved, but also heated. They may also be used in

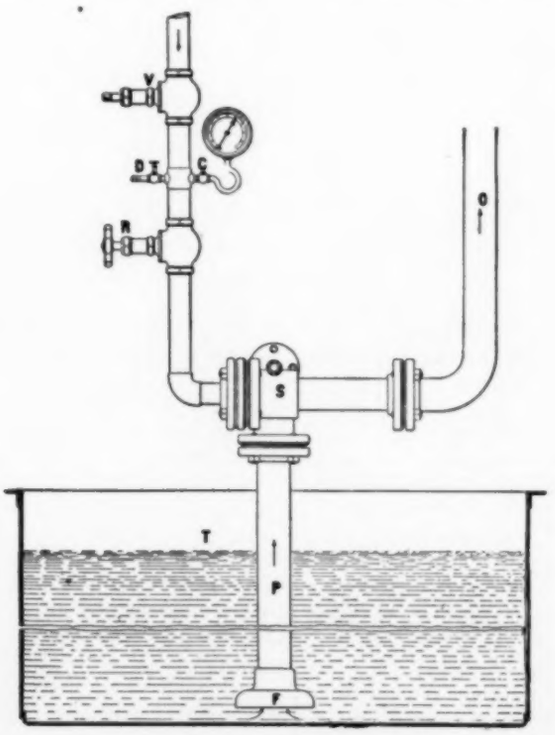


FIG. 3.—LEAD SYPHON.

place of centrifugal pumps for circulating lyes and extracts and a slightly changed construction is successfully applied for artesian wells.

For the lifting of acids and other substances that have a corroding effect upon brass and iron the syphons are made of lead, stoneware or percelain.

Fig. 3 shows the arrangement of a lead syphon. C is the

check valve, D the drain, F the strainer, O the delivery pipe, P the suction pipe, R the stop valve, S the syphon, T the tank, V another stop valve.

No lead burning is required in making connection to the syphon, as the lead pipe is flanged through and smooth and is fitted to the syphon by means of suitable counter flanges. The flanges must be bolted perfectly tight and firm so that no leaks occur. It is generally recommended to fix the syphon a foot or two above the liquid, so that the liquid has to be drawn up and the syphon empties itself when not in operation.

The steam pipe should be blown out with high-pressure steam before connection is made to the syphon. When there are lumps or floating particles in the supply a strainer should be attached to the suction pipe. The syphon works best in any given case at a certain steam pressure, which has to be found out by throttling the steam. Therefore, when such a syphon is installed it should be arranged as shown in the cut.

Valve V is throttled to the most favorable steam pressure and locked in that position. Valve R is used for operating the syphon only. Before starting the syphon valve D should

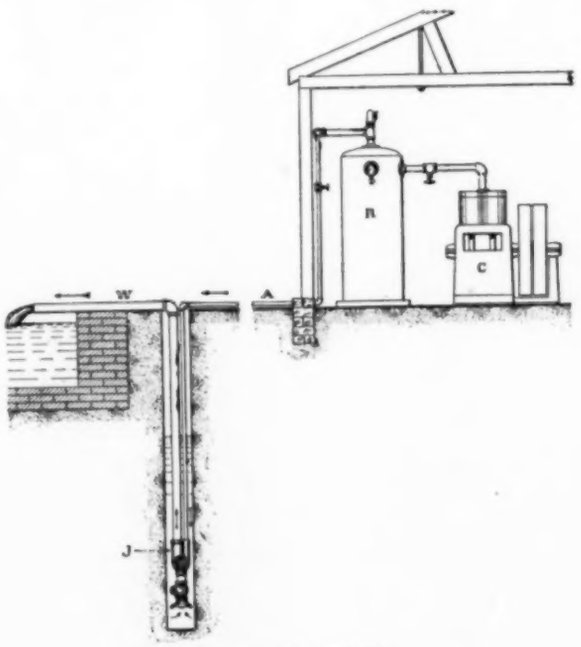


FIG. 4.—AIR-JET LIFT.

be opened in order to draw off any condensed liquid. Care has to be taken that no traps occur in the delivery pipe and that the suction pipe is perfectly air-tight.

Air-jet lifts are simple and efficient means for lifting liquids by means of compressed air, especially in places where piston pumps or steam jets cannot be used. The working of the air-jet lifts is as follows: Air is pressed into the lower end of a submerged pipe. The air mixes with the water inside the air-jet lift and forms a mixture of air and water which is lighter in specific gravity than water alone. The column, consisting of air and water, is therefore driven upwards. In other words, the apparatus works through the difference of specific weight of the two columns.

The arrangement, shown in Fig. 4, consists of the discharge pipe W, the air-pressure pipe A, and the apparatus proper J. The discharge pipe may be any kind of pipe which discharges the water freely so that the water can get rid of the air.

The apparatus is so constructed that the air is distributed as uniformly as possible over the area of the water discharge pipe. In cases where the machine is put in a well there is usually provided a strainer on the inlet of the apparatus. In cases where the water is carried to the machine by means of a pipe, the connection of the apparatus is made by means of an elbow. The discharge pipe and the air pipe are placed as close together as possible, so that the apparatus can be installed in narrow wells.

The apparatus is to be installed as deep under the level of the liquid as to correspond to the height of lift. To operate the apparatus it is only necessary to open the valve in the air pressure line, the quantity of liquid being regulated by varying the quantity of compressed air.

Further advantages are that it occupies little space and can be easily erected in sulphuric acid plants (for which purpose it is made of lead, stoneware, hard rubber or porcelain) at the foot of the tower in ordinary sewer pipes, which are sunk in the ground according to the height of discharge. The apparatus throws the acid directly into the interior of the Glover and Gay-Lussac towers by letting the discharge pipes extend through the top of the towers. By arranging a plate inside, against which the acid is forced, the ordinary distributors on top of the tower are eliminated in a satisfactory manner. The acid air-lift uses less compressed air than the acid egg and can be made of suitable material. For lifting sulphuric acid it is made of lead; for lifting concentrated acid, of cast iron; for nitrate acid, of stoneware.

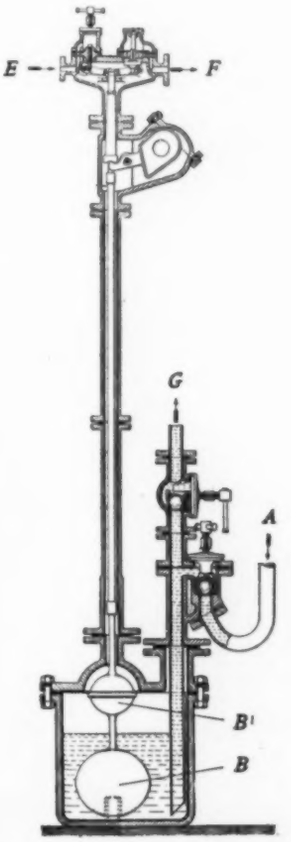


FIG. 5.—AUTOMATIC MONTEJUS.

Automatic Montejus.—In this apparatus compressed air is also used for lifting a liquid. It is extensively applied in acid works, especially in the form shown in Fig. 5. In this type the liquid has run to the machine by gravity, entering at A through a check valve. Let us assume that the tank is empty and that the full weight of the lower float B keeps the exhaust valve F open, so that the liquid can freely run into the tank. The liquid rapidly covers the lower float B, but the buoyancy thus started is not sufficient to open the air valve E. This is accomplished when the liquid reaches the upper float B^1. The combined buoyancy of both floats shuts the air exhaust valve F and opens the compressed air inlet E, the liquid being now discharged through the check valve and the discharge pipe G.

The level of the liquid drops now rapidly below the float B^1, but the weight thus exerted is not yet sufficient to shut the compressed air inlet valve. This is accomplished after the liquid has dropped below float B, the weight of the floats being now sufficient to shut the air inlet valve and to open the air relief valve. The conditions are now again the same as at start and the operation is repeated. These acid eggs are made in the following styles, entirely of cast iron, lead lined or entirely of copper.

Water Jet Eductors.—This apparatus, which, like the injectors and syphons shown, is built by the Schutte & Koerting Co., Philadelphia, is used to lift liquid by means of water under high pressure. It is especially useful where high-pressure water is at disposal and in places where, on account of in-

sufficient space, a pump cannot be installed. The actuating water can either be taken from a local source, such as water works, a natural water source, etc., or can be supplied by pressure pumps.

The motive power is pressure water passing through the apparatus with great velocity. This creates a vacuum and sucks in the water to be lifted, which is then carried along with the pressure water to the discharge outlet. Fig. 6 illustrates one of these eductors. A is the eductor, Z is the height of lift.

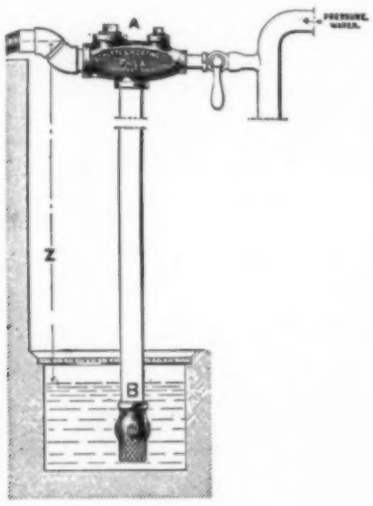


FIG. 6.—WATER-JET EDUCTOR.

These pumps have the following advantages: They have no valves or any moving parts; they are not subject to wear and tear and cannot get out of order; they are noiseless in operation, and they are the simplest and most convenient apparatus when high-pressure water is at disposal.

SYNOPSIS OF PERIODICAL LITERATURE

Furnace Construction.

Fire Brick.—The old practice of cutting bricks to shape for fitting into the walls of furnaces has been done away with in most cases by the use of special shapes of fire bricks. In an article on the "Lining of Heating and Melting Furnaces," in the Oct. 15 number of *Iron Age*, Ulrich Peters describes the special shapes in most common use and their application to special cases. A number of formulas for the design of such special forms as arches and circles to conform to the special shapes of bricks are given of value to the bricklayer.

Basic Refractories.—The use of basic refractory materials is at present very much limited. This may in part be due to lack of knowledge of their durability in special cases, it being the point particularly brought out in the Oct. 24 issue of the *Engineering and Mining Journal* in an article by F. T. Havard. Magnesite bricks are recommended for the lining of reverberatory copper furnaces in place of the ordinary fire-clay brick commonly used for this purpose. The brick resists very well the corrosion due to the slags used, but will not withstand the scouring action of a moving metallic bath. At high temperatures they become soft and wear away rapidly. In the lead reverberatory all brickwork coming in contact with the metal or slag should be magnesite or chromite. This latter material is used almost exclusively for the walls and hearths of cupelling and test furnaces. Chromite is really the only material that resists the corroding influences at work in the reverberatory furnaces used for the reduction of antimony. But little attention has been given to the use of the two materials mentioned above for the lining of crucibles of copper blast furnaces. As these furnaces are always water-cooled, magnesite is well adapted for this purpose, the cooling of the brick being sufficient protection against their disintegration. Magnesite bricks should always be laid in a mortar composed of magnesia and tar, water never entering into its composition.

Open-Hearth Port.—A new water-cooled port for open-hearth furnaces is described, with drawings, in the Oct. 15 number of *Iron Age*. It consists of a series of 2½-in. iron pipes side by side in arch form brought in through the end wall of the furnace. The pipes are protected by special hollow bricks. The pipes all end in a bronze casting forming the outside face of the arch. To keep this in place and also to maintain the sides of the port a special water-cooled skewback casting of bronze is used. The whole arrangement offers a satisfactory solution of a most difficult problem of maintaining the sides and top of the open-hearth port.

Iron and Steel.

Dry Blast.—A most complete description of an actual installation of the Gayley dry-blast system was presented to the American Institute of Mining Engineers at the Chattanooga meeting by Mr. E. B. Cooke, furnace manager of the Warwick furnaces at Pottstown, Pa., where a large installation of this system was recently made. These furnaces are merchant furnaces and consequently are guided in their running by the order book. It has always been a question as to the advantages to be gained from the application of this system to such a furnace, a question solved most completely by this interesting analysis. The paper has been reprinted in *Iron Age* of Oct. 1 and *Engineering and Mining Journal* of Oct. 24. The furnace plant consists of two stacks, one about 70 ft. high and the other 100 ft. high, the system being used in both of them. The refrigerating plant consists of five units with a total refrigerating capacity of 875 tons per day, and requires 1100 hp. This multiplicity of units makes the plant well able to economically take care of the varying conditions represented in the extremes of winter and summer. In winter only one unit is required. Allowing 4.5 tons of air per ton of iron made, and the capacity of the plant being 720 tons of iron a day, 135 tons of air per hour must pass through the freezing system. In the case of the higher stack, a furnace with 22-ft. bosh and 15-ft. crucible, the use of the dry blast (original moisture in the air averaging 4.5 grains per cubic foot, dried air carrying only 1.5 grains per cubic foot) resulted in the following most marked advantages: A reduction of speed of the blowing engines of 10 per cent; an increase in burden of 5 per cent, and an increase in the silicon content of the iron from 2 to 2.75 per cent. On the smaller furnace the capacity was increased from 1400 tons of iron a week to 1700 tons, the fuel consumption at the same time being reduced from 2200 lb. per ton of iron made to 1900 lb., and all with a blast temperature of 100° lower than previous to the drying. The total cost of drying the air is figured out to be about 10 cents per ton of iron produced, this, of course, representing the maximum of summer running. No extra steam is used for the refrigeration engines, the reduced speed of the blowing engines allowing of more than enough for this purpose. In regard to the explanation of this increased efficiency, that given by Prof. J. W. Richards in his discussion of the same subject before the Mining Engineers some two years ago, seems to be corroborated. (See our Vol. III, page 240.)

Converter Process.—In a most detailed investigation, given in *Metallurgie* for September and October, F. Wüst and L. Laval show that contrary to most published references in the blowing of a basic converter 25 per cent of the phosphorus is removed before all the carbon is burned out. The loss in iron consequent to the removal of 6.7 to 7.8 per cent of impurities amounted to 8.2 and 10.7 per cent, of which 2.7 and 4.7 per cent were burnt during the after blow in order to remove the last tenth per cent of phosphorus. The combustion of this element produces a high temperature and the affinity of iron

for oxygen becomes greater at a high temperature than that of phosphorus. The loss of iron can be diminished by cooling the bath during the after-blow by scrap additions or lime-ore briquets. It is more economical to remove phosphorus in the open-hearth furnace when this element is present in considerable quantities as it can be concentrated in a phosphorus-rich, iron-free slag suitable for use as a fertilizer. The use of dry air increases the soundness of the castings. The use of enriched or of preheated air is not recommended, because of the final high temperature attained. The time of blowing is shortened, but the loss of iron is very high.

Phosphor Steels.—J. De Kryloff, in *Revue de Metallurgie* of last July, gives some properties of some new phosphor steels. Phosphorus in steel causes the formation of a granular structure and great brittleness, both being due to the phosphide of iron formed in the steel. Annealing of these steels causes a marked increase in elongation, in one case of from 1 per cent originally to 14 per cent after quenching and annealing to 750° to 780°. A uniform structure of the steel could only be obtained when the phosphorus content is below 0.07 per cent, a larger proportion preventing the even formation of perlite and cementite.

Gases in Steel.— *Revue de Metallurgie* for July and August contains each an article by G. Belloc on the occlusion of gases by steel. A basic open-hearth steel of the following composition: carbon, 0.12 per cent; silicon, 0.03; sulphur, 0.02; phosphorus, 0.018, and manganese, 0.36, was investigated, gas samples being collected at various intervals of heating and analyses made of them. The disengagement of gas begins between 150° and 400°. The ratio of the volume of the temperature shows a minimum at 200°, a maximum at 300°, a maximum at A_0 between 500° and 550°. A minimum value of this ratio is again found at A_2, 710°. A_3, 790°, again shows a maximum somewhat lower than those previously reached. Alpha iron gives up the gas slowly, the amount evolved, however, increasing with the temperature. The transformation of alpha iron into beta iron is marked by an abundant evolution of gas. The disengagement begins again with the transformation of beta into gamma iron, reaching a maximum toward the end of the transformation, falls off and then increases slightly with the temperature in gamma iron. The transformation of carbon as cementite into temper carbon has no influence on the occlusion of gas if the carbon content is 0.12 per cent. The gas evolved consists of a mixture of CO_2, CO, H and N. CO_2 is disengaged first and forms almost the whole of the gas evolved, but above 550° it begins to be reduced by H. N appears at 550° and persists to the highest temperatures. Above 400° H and CO appear and soon make up almost the total bulk of the gas evolved. The gas is very irregularly distributed through the pieces investigated. At an average depth many times more gas was evolved than from chips taken from the outer surface or the central core. In a special nickel steel, containing 45 per cent nickel and 0.15 per cent carbon, the gas evolved measured 3½ times the volume of the chips taken. Evolution started at 480°. At 500° the gas consisted almost entirely of CO and H. The evolution of N started at 690° and at 960° made up 14 per cent of the gas evolved. In the case of a wire drawn from this same steel the gas evolved measured 10 times the volume of the wire taken.

Manganese Steel for Rails.—Mr. H. M. Steward contributed to *Engineering News* of Oct. 9 a paper on the "use of cast manganese steel rails on curves of the Boston Elevated Railway." The average life of a Bessemer steel rail of 0.40 carbon on a certain curve was 60 days. A rail cast of manganese steel has been in service on the same curve for six years, three months and seven days and is still in use. The average traffic over the Bessemer rail was 1000 cars a day, or 36,000 tons. The traffic over the manganese-steel rail has averaged 1700 cars a day, or 62,000 tons. The cost of maintenance of the manganese-steel rail for this six-year period has been $7.01, against the cost of maintenance of the Bessemer rails for the same time of $41.15. It is not probable that manganese-steel rails will be used on tangents. Their great ductility allows of the ends being pounded down much more rapidly than the harder carbon-steel rails at present in use. The great difficulty in the production of manganese-steel rail makes it rather expensive, though there is some prospect of one being able to obtain rolled rails of this metal at a much less cost than is now charged for cast ones.

Nickel Steel.—Mr. J. L. Waddell has been communicating to the press for some time past a series of articles on the use of nickel steel for structural purposes and has carried out a large series of large scale purposes in this line. He has recently presented to the American Society of Civil Engineers what he calls a "Summary" of this work, this summary being in the form of a paper of more than 200 pages, published in full in the publications of the society. In it he calculates that nickel steel can be used more economically than carbon steels in all bridge structures over 30-ft. span, the proportion entering into their construction being dependent on the span. For instance, a bridge of 1800-ft. span can be built of nickel steel more cheaply than one of 1600-ft. span made out of ordinary carbon steel. The greatest difficulty in the use of this material is in its handling by the bridge shops. They are not at present equipped to punch and drill it. For beams and shapes a 3½ per cent nickel steel is recommended; for eye-bars and parts not to be punched or cut a 4½ per cent nickel steel. The strength of these steels varies from 47 to 54 tons per square inch. The cost of them averages about 1½ cents a pound higher than ordinary structural steels, but the strength for a given weight is 66 per cent greater than carbon steel.

Copper.

Lake Copper.—Some rather interesting information about Lake copper has been brought out in the case of the Calumet & Hecla Mining Company against the Osceola Copper Company in regard to the grades of "Lake" at present on the market. Calumet refines the highest grades of its copper by the furnace, the lower grades being refined electrolytically and mixed with other of its mined coppers, all being from the Lake region. Osceola, Tamarack and Ahneek, but western cathodes, principally from Boston and Montana, and mix these cathodes in equal proportions with their own product, selling it also as "Best Lake."

Copper Smelter.—In the design and construction of a small copper smelter one is often at a loss for data on which to base the design. In the *Engineering and Mining Journal* of Oct. 31 Mr. Charles C. Christensen fills up a large gap in this information in an article on the "construction of a 100-ton copper smelter." Furnaces of rectangular section smelt per day from 3.25 to 3.75 tons of ore and flux per square foot of tuyere section, this capacity increasing somewhat with the height of the furnace. A furnace should not be over 54 in. wide in any case and a 100-ton furnace not over 40 in. For this capacity and this width the length figures out 96 in. long. The blast required is 260 times the hearth area at the tuyeres in square feet expressed in cubic feet per minute. At a blast pressure of 1 lb. per square inch this would require 43 hp to drive the blower. For sampling a 7 x 10 Blake crusher would require 7 hp, one pair of 24 x 8 rolls 5 hp, one pair of 12 x 12 rolls 3 hp, one sampling machine 3 hp, shafting 2 hp, total about 20 hp. About 15-hp pump capacity is required. The whole plant should be provided with at least 100 hp. The article ends with a set of specifications for the whole plant, the same being used in the erection of one of this capacity.

Mine Waters.—At the Copper Queen Mining Company's Bisbee mines the water from the shallow mines, like the Czar and the Holbrook, in which the ores are mostly oxidized, contain 10 grains of copper per gallon, there being pumped up about 300 gal. per minute. The water from the deeper mines does not carry but a trace of copper. The recovery plant for extracting this copper is described by Mr. H. W. Chittenden in

the *Engineering and Mining Journal*, Oct. 31. The plant consists of a series of troughs built in the form of a rectangle, 78 ft. x 108 ft., there being five vertical tiers on three sides and four tiers on the other. In all there are 1650 ft. of these troughs. They are built double so as to facilitate cleaning without interrupting the precipitating operation. The troughs are 3 ft. wide and 20 in. deep, made of 2-in. plank. Iron in the shape of tin cans, gathered cheaply around Bisbee, is the precipitating agent. The top tiers are cleaned every second day, the lower ones less frequently. Cleaning is done by means of a pressure water jet from a hose. A settling tank at the end of the troughs catches the slime in suspension.

Copper Reverberatory.—Various attempts have been made to equip a copper reverberatory with a regenerator, but most have failed. The old checker systems choke up with dust and soon reduce the force of the draft so much that the furnaces refuse to work. Mr. F. A. Leas describes a new type in the *Engineering and Mining Journal* for Nov. 7. The furnace uses oil for fuel, though the system can be applied to any furnace fired by gas or coal dust. From each end of the furnace a long flue is run, they connecting with a common chimney. A reversing valve at the chimney end allows of one flue being directly connected to the chimney, while the other is open to the air, the whole being done by one operation. The gases on passing out through the flue give up their heat to the walls and enter the chimney at only about 500°, and on reversal the air entering the furnace must pass through this heated flue and abstract the heat from the walls. In general the temperature of the gases entering the furnace vary from 1000° to 400°, depending on the time elapsed since reversal. The capacity of the furnace was increased 50 per cent with no additional fuel consumption.

Copper Converter.—C. Offerhaus gives rather a detailed description of the operation of an Anaconda copper converter in *Engineering and Mining Journal* for Oct. 17. The lining used consists of an Idaho silicious copper ore mixed with slurry from a settling tank around the works. Sixteen tons of this material is required to line the converter, 8 ft. diameter and 12½ ft. long. It is tamped in on a special brick lining by an air tamper. One and one-half hours are required for lining and seven hours for drying the same. The converter is charged with nine tons of 45 per cent matte at a temperature of about 900°. The blowing operation lasts two hours.

Lead.

Choking Up of Lead Furnace.—Trouble is usually experienced in the running of a lead furnace by the choking up of the crucible and lead well. A new method of opening such a crucible and well is to dynamite it, the operation being described in *Engineering and Mining Journal* of Oct. 17 by J. N. Goddard. A cartridge is made of one-seventh of a stick of 50 to 60 per cent dynamite by inserting it into a piece of iron pipe which has been carefully lined with asbestos. The ends are plugged with this same material and an iron plug screwed into one end, the other being screwed into a rod of suitable length to allow insertion into the lead well of the furnace. Enough time elapses before the explosion to allow the man who inserts the cartridge to get out of the road of the splash of lead accompanying the explosion, 10 to 25 seconds. Usually one such shot proves sufficient, though several have been successively used. The damage done to the furnace after firing 50 such shots is hardly noticeable.

Broken Hill Ores.

Concentration.—The Broken Hill ores have always been of interest to our metallurgists. The general method of treatment of these ores is well described in an article by G. W. Williams in the *Engineering and Mining Journal* of Nov. 7. These ores consist of an intimate mixture of galena and blende, carrying 7.5 oz. to 12 oz. of silver per ton, the silver being evenly distributed between the galena and blende. The ore is accompanied by a gangue of rhodonite and garnet sandstone of near the same gravity as the valuable content, causing great wear on the crushing machinery and considerable loss in the tailings. At times a clean calcite or quartz gangue allows of very clean separation. The ore is, in general, broken by Blaker Gates crushers to 2-in. size, passed over shaking screens, and sent to rolls set to 3 mm, the oversize from the rolls being sent to a differently set roll to avoid excessive sliming. The final roll product passes to jigs, where about 75 per cent of the lead content is extracted in concentrates running 65 per cent lead. The jigg tailings pass to Krupp or ball mills, are there crushed to 0.5 mm size and are returned to jigs or tables. The tailings from the jigs or tables pass to the dump, where they are stored to await extraction of their zinc concentrates. Average practice extracts from 63 to 75 per cent of the lead content and 36 to 55 per cent silver.

Aluminium.

New British Aluminium Plant.—*Electrical Engineering*, Nov. 12 (London), contains an illustrated description of a new aluminium plant (outside of the former syndicate), which is designed for an eventual output of five tons of aluminium per day. It is located near Conway, in North Wales, the name of the company being the Aluminium Corporation, Ltd. Direct current for the electrolytic cells is derived partly from a 4000-kw high-fall hydroelectric plant and partly from motor-generators supplied from a 20,000-volt, three-phase transmission line of a power company. The electrolytic furnaces are arranged in groups of 25 connected in series, and taking a working current of about 7500 amperes. When working at full power, each water-driven machine will run one group of 25 furnaces with a pressure of 120 to 130 volts. The behavior of each electrolytic furnace is studied by means of a conspicuous low-reading voltmeter, with which each is provided, and which indicates the voltage drop across the terminals of the furnace. The same company has a similar plant at Newcastle which has been in operation for some time. The Aluminium Corporation will also soon have their own bauxite plant plant, their bauxite mines being located in Southern France.

Miscellaneous.

Aluminium-Copper Alloys.—The alloys of aluminium and copper have formed the basis of a very exhaustive study of Messrs. Carpenter and Edwards. Their report was comprised in the Eighth Report to the Committee on Alloys of the Institute of Mechanical Engineers and was also translated into French and published in the July *Revue de Metallurgie*. The physical properties of all alloys carrying from 1 to 13 per cent aluminium are given in tabular and diagrammatic form. The most notable alloy is the one carrying 9.9 per cent aluminium, which has almost exactly the same properties as 0.35 per cent carbon steel.

Calcium Cyanamide.—One method of fixation of atmospheric nitrogen uses the reaction between calcium carbide and nitrogen (obtained from air) to produce calcium cyanamide at an elevated temperature. The decomposition of calcium carbide by nitrogen will not take place at temperatures as high as 1200° with pure carbide. With commercial carbide it takes place at 1100°. The presence of calcium chloride or fluoride acts as a catalyzing agent and causes the reaction to proceed at a much lower temperature. Dr. Gine Pollacci in *Zeitschrift für Elektrochemie* of September recommends potassium carbonate as a catalyzing agent for assisting this reaction. At a temperature as low as 900°, with an addition of 4 per cent of potassium carbonate, he obtained 23 per cent combined nitrogen. The nitrogen pressure in the furnace was 2 atmospheres.

Colloids.—Colloidal solutions are coagulated by the introduction of a metallic couple. Thus, W. Biltz notes in *Zeitschrift für Elektrochemie*, Sept. 4, that in a solution of gold when a zinc-copper couple is introduced no action takes place without the completion of electrical connection between the plates. On closing the circuit all the gold was precipitated as a purple deposit appearing to be an absorption product of gold and zinc hydroxide. The minute quantity of electrolyte present is sufficient to account for the action.

Notes on Electrochemistry and Metallurgy in Great Britain.

(From our Special Correspondent.)

The Iron and Steel Institute Meetings.

The meetings of the Iron and Steel Institute, under the presidency of Sir Hugh Bell, were formally commenced on Monday, September 28, at Middlesborough, Yorkshire. [On account of limitations of space abstracts of the papers presented at the meeting had to be held over for our next issue.—ED.]

The first two papers, namely, "Notes on a Workshop Microscope," by Mr. J. E. Stead, and Mr. W. Hawdon's paper on the "Iron and Steel Industries of the Cleveland District" evoked no discussion. Mr. T. C. Hutchinson's paper on "The Mechanical Cleaning of Iron Ores" was the subject of some remarks.

Mr. H. Pilkington thought the assertion that the picking belt would be applicable to any iron ore did not apply to the Northamptonshire, Nottinghamshire and Leicestershire ores. These districts were growing in importance. Stone there was oxidized, and did not require calcination; some of the ores there were exceedingly lean, and the smelter only got 23 per cent of iron.

Mr. A. Windsor Richards put the matter briefly as the question "at what point was it remunerative to start picking out lean stone?"

Mr. Hutchinson, in his reply, pointed out that Mr. Pilkington referred to Midland ores in which the impurities were mainly lime, whereas in the Cleveland ores dealt with at Skinningrove the impurities were silica. The cost per ton of ironstone discharged into the furnace was just over two cents. This covered interest on capital, redemption and repairs. As to the particular point at which it paid to throw out stone, that everyone must judge for himself. Personally he would throw out all stone and pay for a portion of it with under 27 per cent of iron.

On Wednesday, the 30th, Mr. E. H. Saniter read his paper on a "Test for Ascertaining the Relative Wearing Properties of Rail Steel." In the subsequent discussion Mr. Gledhill said the point in the paper which appealed to him was the superior wearing qualities arising from the percentage of nickel. The use of nickel was, however, so expensive as practically to preclude its employment for rail manufacture. He suggested in place of nickel the use of 1½ to 2 per cent of chrome, which could be obtained at one-seventh the cost of nickel. A high-carbon chrome steel would seem to him to be possessed of good wearing qualities.

Mr. E. H. Saniter in his reply said he had made such a chrome rail and found that it broke into two or three pieces under the drop test.

Mr. Charles H. Merz's paper, on "Power Supply and Its Effect on the Industries of the Northeast Coast," which followed, produced a good discussion. Mr. T. Westgarth, in acknowledging the value of the paper, paid special attention to the use of gas engines. He advocated the use of waste gas from furnaces directly in a moderately large gas engine, and instanced gas-engine developments at Messrs. Hickmans, at Barrow, at Coltness and at Skinnergrove. Although a 5000-hp gas engine was at work at San Francisco, most makers were not prepared to go beyond 3000 hp.

Mr. A. Gouvy said that it might be claimed that a well-designed gas engine could be built for continuous running without calling for more maintenance than a steam engine. The gas used should, of course, be cleaned down to 0.03 gram per cubic centimeter.

Mr. D. Selby-Biggs said that to his list of determining factors Mr. Merz might have added exhaust steam. He had recently been making an investigation in Westphalia and Silesia as to how works were producing their electricity and at what rates. It could be taken that where there was available a waste asset in the form of exhaust steam or blast furnace gas and the power requirements of the works were sufficiently large, it ought to be possible to produce power at the rate of 0.5 cent per kw-hour. From coal it was possible to produce the power at 0.7 to 0.8 cent per unit if large outputs were being considered. In Westphalia, at one place he visited, they were producing between 14,000 and 15,000 horse-power in gas-engine stations, principally for supply to collieries. Mr. Adolph Greiner outlined the system employed at the Cockerill works, where the electricity department sold at 1 cent per kw-hour to the other departments.

Mr. W. Hawdon said that, at Sir B. Samuelson & Co.'s, they had put in as generating plant, low-pressure turbines driven by the exhaust steam of blowing engines. They also generated power by surplus high-pressure steam in a high-pressure turbine, which was a new channel of profit for blast furnace proprietors not connected with steel works.

The second paper on Wednesday, Messrs. C. Koettgen and C. A. Ablett's "Some Results of Experience with Electrically-Driven Rolling Mills," was also, strictly speaking, more mechanical than metallurgical. In the discussion, Mr. A. Lamberton referred to an electrically-driven reversing mill at Messrs. Dorman, Long & Co.'s, and also outlined a method of using a constantly running motor possessing many advantages of the Ilgner system without being so costly to install.

Messrs. W. J. Larke, H. Crowe and A. Greiner spoke on technical points connected with the mechanism.

There was no discussion on Mr. Sherard O. Cowper-Coles' paper "On the Production of Finished Iron Sheets and Tubes in One Operation," which followed (published in our November issue), or on Mr. A. E. Pratt's paper entitled "The Future Development of the Metal Mixer." This was owing to lack of time.

On Thursday, Oct. 1, a paper by Prof. W. A. Bone and Mr. R. V. Wheeler on "Further Experiments Upon Gas-Producer Practice" was read, and one by Prof. Armstrong on "The Scientific Control of Fuel Consumption." Being similar in subject, both papers were discussed together. Mr. A. Sahlin, on this subject, said that his firm had, by experience, established the rate of gasification in producers with undisturbed fuel bed at from 10 lb. to 18 lb. per hour per square foot of fire surface, irrespective of type. By agitating the fire zone they found by experiment that as high as 32 lb. per square foot could be reached. Mr. Lindsay Forster referred to some experiments with blast at temperatures of 52°, 55° and 60° C., in which satisfactory results had been obtained at the lowest temperature. Prof. Bone instanced a German works where the blast was used as low as 45°, but they were only gasifying from 10 cwt. to 12 cwt. per hour, and were working with cold blast.

Mr. R. V. Wheeler then read a paper on "The Chemical Control of the Basic Open-Hearth Process," written in conjunction with Mr. A. Harrison. In the discussion, Mr. Adolph Greiner said it was of great importance that the steel maker should know what was going on in the bath and that different phases of the melt should be carefully followed. He believed in analyses—if analyses could be made quickly—and at Seraing they had the means of making analyses accurately, simply and quickly. The determination of carbon took about 10 minutes, sulphur a little more, and manganese 9 to 10 minutes, while by the new method they could arrive at the phosphorus in less than 10 minutes.

The authors said that the elimination of sulphur could not be relied upon, but they were using the Saniter process with fluorspar to obtain their results. They credit the Talbot process with a desulphurizing effect, which was not claimed by the inventor. The very low loss of manganese was probably due to oxidation, but if not due to oxidation it did not correspond with the elimination of sulphur shown in the steel. Analytical methods had been used in the Middlesborough district for the last 10 years, and the methods suggested by the author were not the best which could be employed. He certainly objected to burning color carbons in a gas flame with the expectation of getting a good result.

The remaining papers for this day were Prof. Carpenter's on "The Freezing Point of Iron"; Prof. E. D. Campbell's on "The Constitution of Carbon Steels," and Mr. A. Jouve's, "On the Influence of Silicon on the Physical and Chemical Properties of Iron." These, unfortunately, were not discussed, probably owing to the limited time available.

Sulphur in Iron Ore.

At the meeting of the Staffordshire Iron and Steel Institute, on Oct. 17, Mr. Stead gave the results of a number of experiments recently made in his laboratory to determine the relative harmfulness of different sulphur-bearing minerals in iron ores. The experiments were made with iron ores mixed with iron pyrites, sulphate of lime and sulphate of baryta, respectively, and then smelted in crucibles. The several mixtures were smelted in large plumbago crucibles divided into sections, so that comparative smeltings could be done at the same time and under the same conditions. The various mixtures were placed in pockets in the crucibles, which were then heated for an hour to about 900° C., and finally for half an hour to near whiteness. The lining of the crucibles was, in the first trial, coke dust, and in subsequent trials, charcoal powder mixed with starch paste. Mr. Stead summarized his results as follows: "In reviewing the work and averaging the results it will be seen that the average of No. 1 BO 4 series indicates that 1 per cent of sulphur in the ore in the state of Fe_2S — $CaSO_4$ and $BaSO_4$ leaves sulphur in the pig in the following proportions: Pyrites, 100 sulphur; calcium sulphate, 94 sulphur; barium sulphate, 91 sulphur. These results must not be taken as absolutely indisputable, but approximate only. They show how readily sulphur in any combination is liable to be retained by the iron in the blast furnace. It seemed reasonable to believe that the bases, calcium and barium, associated with the sulphur in calcium sulphate and barium sulphate must check the sulphur from passing into the iron, but, as a matter of fact, their influence in that direction is very feeble. To place the question absolutely at rest, the comparative smelting should be done in gas-fired furnaces and the temperature be controlled by pyrometer."

Smoke.

In his paper before the Association of Engineers-in-Charge Mr. J. Swinburne made some very pertinent remarks on the subject of "Smoke." He distinctly accuses the furnace, as in ordinary use, of imperfect combustion. It does not appear at first sight, says the author, easy to raise smoke to a high temperature, but it was not impossible. The gases from hand-fed fires were generally led straight to iron surfaces cooled by the water of the boiler, so that the tar had no chance of getting burned. If the fire were itself in a fire-brick chamber, and the gases had to pass over a reasonable amount of white-hot fire-brick before any attempt was made to abstract the heat, it is quite possible there would be no smoke even with hand stoking. He believed the general principle in furnaces of abstracting heat from the fire and gases at the earliest possible moment was entirely wrong. He suggested that the proper way was to leave the gases as long as possible before beginning to cool them, and not to heat the boiler shell or tubes by direct action of the fire or even by radiation from it. No heat should be taken from the fire or from the gases until all the smoke was completely burnt. The boilermaker seemed to have a fixed idea that the fire ought to be inside the boiler, and the water ought to be as close to the fire as possible. In reality, the fuel was too close to its work. The idea that the best way to heat anything was to put it right into a flame was very widespread. The Bunsen burner, the table and laboratory spirit lamp, and gas stoves were familiar examples. The gas engineer has at last found out this simple thing, that the burner must not play on the saucepan. The products of incomplete combustion coming into a room as the result of burners playing on lumps of clay or asbestos were far worse than the products from the same amount of gas burned by Bunsen or bat's-wing burners. In boilers there is no reason why the furnace should not be outside in the form of a fire-brick structure in which is allowed ample room for the hydro-carbons and air to mix thoroughly and time for the combustion to be complete.

Blast Furnace.

A new type of blast furnace has recently been erected at the Brymbo Steel Co.'s works, near Wrexham, by the Pearson & Knowles Coal & Iron Co., Ltd., of Warrington. This new furnace is 70 ft. high and has a hearth diameter of 11 ft., the height of which above ground level is 8 ft. 6 in., so that hot metal may be run direct into ladles for transference to the steel works mixer. The furnace top is closed by a bell and hopper, the former being arranged with a 5-ft. central tube forming the gas out-take for the furnace. The connection between the moving bell and the fixed vertical gas off tube is maintained gas-tight by a water seal. With this arrangement the stock line of the furnace is nearer the level of the charging platform than is the case with furnaces having the usual side down comers, consequently there is less breakage of coke during the charging of the furnace. Further, there is the additional advantage secured by causing the gas leaving the furnace to pass finally off from the center. The Brymbo Steel Co., Ltd., have a large installation of gas engines for power purposes, which are worked from their blast furnaces, and as it is found to be advantageous to their regular working to prevent fluctuations in the gas pressure when the furnace bell is lowered, the furnace hopper is entirely closed by means of a hood during this period. The bell and hood are worked by separate steam cylinders at the top of the furnace. The furnace is provided with a steel bosh jacket arranged to be cooled by three sets of water-spray pipes and petticoat drip rings. The cooling water is drained away by a circular trough at the bottom of the jacket. There are eight forged copper tuyeres fitting into water-cooled circular blocks made of cast copper, which in turn are carried in a cast-steel tuyere belt encircling the hearth of the furnace. Access to the tuyeres is given by a platform carried up on the furnace columns. The water supply to the tuyeres is worked on an equilibrium system which is a combination of the usual pressure system and the Foster vacuum system, and so arranged that there is an ample flow of water to the tuyere nose, notwithstanding the fact that the pressure at that point never rises over 2 lb. above atmospheric pressure. In the furnace casing above the lintel there are fitted 144 cast-iron cooling blocks arranged in eight rows, access to which is obtained by two circular platforms reached by a stairway from the ground. Cast-iron blocks are inserted in the brickwork near the stock line so as to protect the bricks from the falling stock. The gas passes from the tube above the furnace bell into a dust-catcher having a coned top and bottom.

Platinum.

The *Chemical Trade Journal*, quoting from a report of Lieut. I. A. Lossiev to the Russian Minister of the Interior, gives some interesting information on the position of the platinum market. It is expected that the decline in price will continue for some time yet, until all the small and medium platinum concerns in the Urals have been completely ruined. Even now at 4 rubles per pood, many places in the northern Urals are being worked at a loss. The continuous decline in the value of platinum is due to the maneuvers of several groups or syndicates of foreign capitalists, who are exerting every effort to get control of the Urals plantinum industry (practically the only one in the world) in order to control the production and the market as well. The plan of the syndicates has apparently been to buy up all the government platinum areas available, and to buy in advance the production of all the large platinum houses. It is suggested that the government should intervene, prohibiting the exportation of crude platinum and allowing only refined metal to be exported.

Electric Units.

The International Conference on Electrical Units and

Standards held its first meeting on Monday, Oct. 12, when attention was principally directed to the definition of the ohm. Lord Raleigh expressed the opinion that it might be better not to adopt a mercury standard at all, because absolute methods of measurement would probably very soon give us all that was necessary. Mr. Trittee also, from another point of view, was by no means in favor of mercury standards, for the reason that such standards have not met with any great success among the general body of workers in this country. There was also a question whether the length and weight of the mercury column should be fixed once for all. Dr. Warburg was of the opinion that this should be so, as it was extremely inconvenient for commercial purposes to have different values from time to time. The suggestion was made by Dr. Rosa that the length of the mercury standard should be fixed once for all as 1 m, the weight being correspondingly reduced.

This was, in the form of a resolution, ultimately rejected by the technical committee.

The second meeting of the conference took place on Wednesday, Oct. 14. The question under consideration was Resolution V, that the ampere is the second primary unit. After some discussion, and a proposal in favor of the volt as the second primary unit, the meeting decided in favor of the ampere, defined by the electrochemical equivalent of silver. The exact figure to be adopted was referred to the technical committee.

The proceedings of the technical committee on Wednesday, Oct. 14, effected no change in the figure for the electrochemical equivalent.

On Thursday, Oct. 15, the committee suggested various emendations in the directions for ascertaining the mercury ohm, and referred the final drafting of the specification to a sub-committee.

The committee then considered further the value of the electrochemical equivalent of silver, and adopted finally the figure 0.001182.

On Friday, Oct. 16, the conference, on the motion of Dr. Glazebrook, decided to adopt the recommendation of the technical committee "That the conference do not alter the length of the mercury column in the definition of the international ohm from 106.300 cm to 1 m."

The ampere was then further discussed, and the final figure for the electrochemical equivalent accepted as 0.00111800.

The conference then recommended the adoption of the international ohm, ampere and volt, as defined by them, for the purpose of electrical measurements, and as a basis for legislation, and recommended the establishment of a permanent commission to secure uniformity of administration in relation to electrical units and standards in the future.

Exhibition.—At the Franco-British Exhibition the following awards have been made in the department of electrochemistry; Diploma for grand prize, Sherard Cowper-Coles & Co., Ltd.; diploma for gold medal, Berry, Skinner & Co.; Ozonair, Ltd.; Dr. Henry F. S. Sand.

Market Prices.—Tin has had a downward tendency for the latter part of October, reviving somewhat on the 19th. The price started at £134 and is now (Oct. 27) in the neighborhood of £133.

Copper has been fairly steady, and is at present, if anything, inclined to harden. Commenced, £59 15 0; present price, £61.

English Lead has been steady in the neighborhood of £14.

Hematite has fallen pretty generally throughout the month. On the first £3 0 6 was quoted, which had fallen by the 18th to £2 19 0, and by the 23d to £2 18 9.

Cleveland Warrants have dropped from £2 10 0 to £2 8 6. A pretty steady decline.

Scotch Pig also down from £2 16 0 to £2 14 0.

Chemicals:

Sulphate of ammonia, f. o. b. Liverpool, per ton	£11	10	0
Copper sulphate, per ton	19	5	0
Caustic soda, white, 77 per cent, per ton	11	2	6
Bleaching powder, 35 per cent, per ton	4	5	0
Antimony, black sulphide powder, per ton	25	0	0
Shellac, Standard T., Orange Spots, per cwt	4	15	0
Carbolic acid, liquid, 97 to 99 per cent, per gal	1	0	
Creosote, good ordinary liquid, per gal		2½	
Naphtha solvent, 90 per cent at 150 deg. C., f.o.b, per gal.		10½	

RECENT METALLURGICAL PATENTS.

Iron and Steel.

Dry Blast.—Mr. Gayley's dry blast system has the great advantage of increasing the output of a blast furnace to a very considerable extent and at the same time makes its operation independent of the weather. A new method for removing the moisture from the air used for the blast is patented by Mr. Louis Block, formerly connected with the De la Vergne Machine Co. (903,353, Nov. 10, 1908). He compresses the air to a tension greater than the "furnace tension" (i. e., the pressure, say, 20 lb. above atmosphere, at which the air blown into the blast furnace through the ordinary twyers after being heated in the stoves is able to overcome the resistance and rise upward through the charge of the blast furnace). The heat of compression is disposed of by cooling the compressed air by water, or, still better, by cold air after it has deposited its moisture. After this treatment has cooled the compressed air and condensed any surplus moisture, the air is allowed to again expand and thereby to drive an engine which aids in the compression of the air. The arrangement in its simplest form is shown in Fig. 1. *A* is an air compressor. A^1 is a pipe of

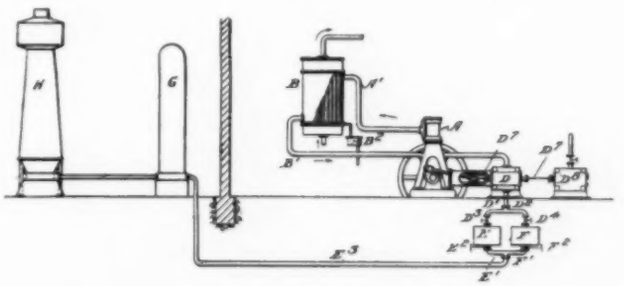


FIG. 1.—DRY-BLAST SYSTEM.

sufficient capacity conducting the air at high tension, say, 60 lb. per square inch, and at a high temperature due to the compression to the moderate cooler or condenser *B*, which is a strong casing provided with tubes. Ordinary river water or well water, if such can be commanded, is passed through the spaces between, while the hot compressed air flows through the tubes. The purpose being to expose this air to metal of sufficient area kept at near the temperature of the cooling medium, say, 35° to 90° Fahr. B^1 is a pipe carrying away the air still under its high tension and cool, but not cold. It is shown as leading directly to the cylinder *D* of a motor-engine, analogous to a steam engine. It may be an ordinary steam engine with suitable provisions for thawing if a valve becomes clogged by ice. In this cylinder it is caused by suitably actuated valves to act alternately on the opposite side of a piston, not shown, and through a piston rod D^7, to aid in driving the compressor *A* or to do other useful work. The admission-valve or valves should be worked in the same manner as the corresponding parts in a good steam engine so as to cut off the supply of air when only a third or some other fraction of the stroke has been performed and thus to obtain power from the expansion as well as from the admission of the air, and utilize as far as may be all the power derivable from the expansion of the air from near the high tension, say, 60 lb. per square inch by gage, at which it left the compressor *A* too near the blast-furnace tension (say, 20 lb.). D^3 and D^4 are divergent pipes controlled by valves D^3 and D^4, arranged to conduct the expanded air to snow boxes *E* and *F* of ordinary construction. The pressure is now down to that required to serve in the blast furnace. The soft ice or snow, if any is deposited, may be alternately re-

moved from the snow boxes, and the air pretty thoroughly rid of its moisture, may be conducted by any suitable passages or vessels, as the pipes E^1, E^2 and F^1 controlled by the valves E^2, F^2, connecting to the stove G, and after being there heated, flows through the twyers into the blast furnace H. A more elaborate form of apparatus, in which the compressing is effected in two stages, is also described.

Copper.

Leaching Process.—A modification of the Hunt and Douglas process is patented by Mr. Fred. Laist, of Butte, Mont. (903,732, Nov. 10, 1908). The process relates to leaching oxidized copper ores with a dilute solution of sulphuric acid which contains chlorine in the form of a chloride, such as sodium chloride, ferrous chloride or calcium chloride, in quantity sufficient to form the sub-chloride with the copper. Having dissolved the copper from the ore, it is to be precipitated from the resultant solution as the sub-chloride, or cuprous chloride (Cu_2Cl_2). This is done preferably by running the cold solution down an absorbent tower up which sulpher dioxide gases (generated by burning pyrites, sulphur, etc.) are passing. The sulphur dioxide is absorbed by the cold solution, so that a solution containing 2 per cent to 4 per cent of sulphur dioxide is obtained. The percentage of sulphur dioxide gas absorbed must be at least one-half of the percentage of copper which the solution contains. This solution is now run into a boiler, lined with an acid-proof metal, and containing steam coils for heating and a safety valve adjusted to go off at about 15 lbs. pressure. Here it is brought to boiling and the following reaction takes place:

$$2CuSO_4 + 2NaCl + SO_2 + 2H_2O = Cu_2Cl_2 + 2H_2SO_4 + Na_2SO_4$$

or more simply stated

$$2CuCl_2 + SO_2 + 2H_2O = Cu_2Cl_2 + H_2SO_4 + 2HCl.$$

The cuprous chloride being insoluble separates out, especially on cooling the solution, as a white crystalline powder which is collected and dried and which can readily be converted into metallic copper. The solution, which contains a large amount of regenerated acid, is used for leaching fresh quantities of ore. The essential differences from the Hunt-Douglas process consist in absorbing the sulphur dioxide in the cold copper solution and then heating under pressure to complete the reaction between the sulphur dioxide and the cupric chloride. The Hunt-Douglas method was to inject sulphur dioxide into the hot copper solution. This method is not nearly so economical of sulphur dioxide nor so convenient of manipulation as the present modification. Moreover, the sulphur dioxide obtained in practice always contains some oxygen. Hence an oxidation of the precipitated cuprous chloride always accompanies the reduction of the cupric chloride, which makes it impossible to obtain a complete conversion of the copper into cuprous chloride. In the new modification this does not take place, since the oxygen comes in contact only with the cold solution and before the formation of cuprous chloride has properly started. Heating under pressure very materially aids the reduction, because it keeps the sulphur dioxide in the solution until the reaction temperature (which is near 100° C.) is reached. It is very difficult to obtain a precipitation of more than 75 per cent of the copper in the solution when heating in the open. Under pressure 90 per cent to 95 per cent can be brought down. In fact, the completeness of precipitation is limited only by the slight solubility of cuprous chloride.

Miscellaneous.

Melting and Refining Furnace.—S. T. Bleyer patents (903,163, November 10, 1908) a modification of the well-known Schwartz furnace of the Hawley Down Draft Furnace Co. of Chicago. It is specially suitable for brass and steel. Sections of the whole of the furnace and of the melting chamber are shown in Fig. 2. It is a tilting furnace with a charging opening 9, and a pouring outlet 12. The burner comprises two nozzles 13, inserted through the upper part of the furnace body above the outlet 12 and connecting with an air supply pipe 14. An oil supply pipe 15 communicates with two injectors 16 inserted in the nozzles or burners proper and adapted to supply the fuel which is vaporized and mixed with air and burned in the furnace chamber to make intense flame jets for melting any metal on the hearth. This hearth is flat in order that all the molten metal thereon shall be of unform depth. The air blast mechanism comprises a series of twyers 17, arranged at opposite sides

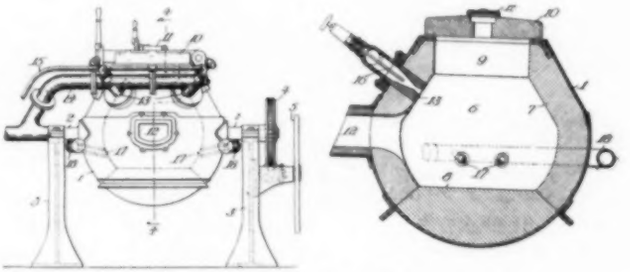


FIG. 2.—MELTING FURNACE.

of the furnace and having an angular disposition with respect to the burners of somewhat less than 90°. These twyers are located below the trunnions and above the line of metal when molten and are directed slightly downwardly, so that the air blasts discharged therefrom will strike the metal. Moreover, these twyers are arranged in two pairs at opposite sides of the furnace, the members of each pair converging, with the result that the air blasts focus substantially at the central axis of the furnace. The air is supplied to the twyers through an air supply pipe 18 curved around a little more than half of the furnace and connected to the twyers. The operation is as follows: The metal to be melted is placed upon the hearth and the burners 13 are started, whereby the metal is melted. If it is desired to also refine the charge, the burners are shut off and the twyers are opened, whereupon air blasts are directed against the body of the metal.

ANALYSIS OF CURRENT ELECTROCHEMICAL PATENTS.

Electrolytic Processes.

Metallic Tubes by Electrolysis.—Tubes, etc., have been made in the past by electrolytic deposition according to various methods, the essential feature of all of which is thorough circulation of the electrolyte, generally by rotation of the cathode. Fig. 1 shows an apparatus of Paul Borgnet, Liege, Belgium (903,164, Nov. 10, 1908). The two mandrels 4 on which the metal is to be deposited are revolved by means of the belts 5

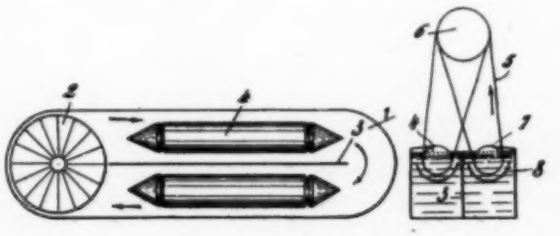


FIG. 1.—METALLIC TUBES BY ELECTROLYSIS.

driven by the pulley 6. The anodes 8 are arranged in proximity to the mandrels 4, which are the cathodes. Besides revolving the cathodes the electrolyte is further circulated by means of the wheel 2.

Electroplating; Alcohol Electrolyte; Plating on Aluminium.—Solutions of metallic salts in water are the rule in electroplating, although in special cases, where the desired deposit would react with water, it has been suggested to

employ other solvents than water. O. Meyer (902,755, Nov. 3, 1908) patents the use of a plating bath, consisting of a solution of a chloride of the metal to be deposited in alcohol. He states that the alcohol may be either commercial ethylalcohol or methylalcohol or denatured alcohol. The chief advantage desired is the practical suppression of the evolution of hydrogen gas on the surface to be plated. The electrolyte may be made by dissolving the metal chloride in the alcohol. Another way is to add one or several per cent of pure, concentrated hydrochloric acid to commercial alcohol and start electrolysis with an anode of the metal to be plated whereby the metal chloride is produced by anodic reaction. It is stated that in this way, at ordinary temperature and without any further additions, an "excellent electrolyte" is formed for depositing gold, copper, nickel, cobalt, tin and is produced by anodic reaction. metallic form. From 2½ to 3 volts are said to be required. The process is not applicable for plating with silver and lead, and is not recommended for plating with platinum and zinc. It is claimed that alloys (like brass) can be easily deposited by this method, either by dissolving a mixture of various metallic chlorides in alcohol or by employing anodes made of different metals. Zinc, nickel, copper and tin may form a variety of colors on the same cathode. Alloys of other metals with aluminium (though not pure aluminium) may also be deposited. The process is also stated to solve in an easy way the problem of plating other metals upon aluminium. The trouble has always been supposed to be due to the invisible film of aluminium oxide, which always exists on aluminium surfaces and which prevents other metals from sticking. If the aluminium surface to be plated is first made anode in the alcohol plating bath, the oxide film is reduced within a few minutes, and when then the connections are reversed and the aluminium surface is made cathode, the oxide film does not form again in the alcohol solution and "the electrodeposited metal strikes upon real, bare aluminium and adheres to it."

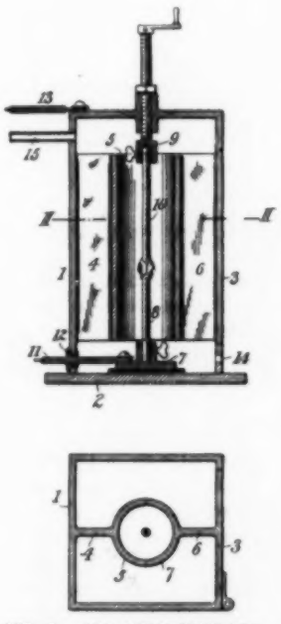


FIG. 2.—ARC APPARATUS FOR FIXATION OF ATMOSPHERIC NITROGEN.

Electrotypes.—In the manufacture of electrotypes lead has to a considerable extent supplanted wax as a matrix material. To facilitate the separation of the electrotype from the lead matrix, the latter is usually covered with a film of graphite, and this is satisfactory in many cases, although difficulties are experienced when the matrix has deep cavities. C. Revrdys (903,404, Nov. 10, 1908, assigned to F. Wesel Manufacturing Company of Brooklyn) treats the lead matrix with carbonic acid to produce a thin film of carbonate of lead. This film has no bad effect on the deposition of the electrotype, while it renders its subsequent operation from the matrix very convenient. It is recommended to employ the carbonic acid gas under heat in order to quicken the reaction, and for this purpose the inventor employs a jet of gas on the surface of the matrix by an air blast or by the use of steam. An oily or fatty substance, such as paraffine, oil or an alcoholic solution of rosin, may be added. The blast of the gas entrains the oily substance so that it is spread upon the surface together with the gas.

Discharges Through Gases.

Fixation of Atmospheric Nitrogen.—In the evolution of processes for the fixation of atmospheric nitrogen the tendency has been marked to use arcs rather than sparks and the endeavor has been to get as large an arc surface as possible (for instance, by spreading the arc out by means of an alternating magnetic field in the Birkeland-Eude process). It was therefore to be expected that the progress made in the last years by illuminating engineers with the so-called "flaming arc" would be made use of by electrochemists. Flaming arcs are produced between chemically impregnated electrodes and one of the characteristic features of the flaming arc is that light is given off not only from the incandescent terminals of the electrodes, but from the vapor zone between the electrodes and that the electrodes can be drawn further apart than is possible with ordinary carbon electrodes. I. L. Roberts (902,607, Nov. 3, 1908) recommends for these reasons the flaming arc for the fixation of atmospheric nitrogen and patents specifically the use of chromium-iron electrodes. They are made by casting an alloy of iron and chromium, containing "as large a proportion as possible" of chromium. The apparatus is shown in Fig. 2, where 8 and 10 are the electrodes. The air enters at 14 and leaves through 15. The fixation of the nitrogen occurs in the inner cylinder. The surrounding ring-shaped space of air serves as heat-insulator. The inner cylinder is constructed in halves 5 and 7. The half 5 is connected by the thin web 4 with wall 1, while the half 7 is connected by web 6 with the removable door 3 in the opposite wall. It is, therefore, easy to take the apparatus apart for inspection and renewal of electrodes.

Ozone.—At the recent Navy Exhibition in Berlin two systems of ozone ventilators were shown. The Siemens & Halske Co. arranges the ozonizer tubes on the inner side of rectangular vessel, and the ventilator throws the ozonized air into the outer spaces. The Allgemeine Elektricitäts Gesellschaft makes use of the fact that the incandescent Nernst filament ozonizes the surrounding air. In their apparatus the air is driven along the filament by a small ventilator. (Elektrotech. Zeitschr., Oct. 29.)

Storage Batteries.

Formation.—Storage battery plates have been formed before by anodic treatment in a mixed solution of sulphuric acid and nitric acid. The disadvantage is that the nitric acid is converted during electrolysis into nitrous acid. To prevent this, W. Morrison (903,752, Nov. 10, 1908) adds to the mixed solution a soluble salt of manganese, such as a permanganate of potassium. Its effect is to convert the nitrous acid back into nitric acid and also sulphurous acid back to sulphuric acid.

Automobile Battery.—Mechanical details of construction of a battery for use in automobiles are patented by John L. Smith and Malcon O. Smith (903,799, Nov. 10, 1908). The first claim refers to "a storage battery cell comprising two lead plates, two elastic non-conducting frames in which the edges of the plates are seated, and a mud guard frame of non-elastic non-conducting material clamped between the plate-holding frames, each frame being composed of two side bars and a bottom bar, the vertical dimension of the bottom bar of said mud guard frame being greater than that of the corresponding bars of the plate holding frames between which it is clamped."

Electric Furnaces.

Alloy for Resistors.—An alloy suitable for electric heating and rheostat work and for resistors for electric furnaces, on account of its high electric resistivity and its ability to withstand a red heat for long continued service, is patented by John T. H. Dempster (901,428, Oct. 20, 1908; assigned to General Electric Co.). It consists essentially of 62 parts by weight of nickel, 20 iron, 13 chromium, and 5 manganese. The alloy can be rolled and drawn into extremely fine wire or ribbon, having a resistivity of 117 microhms per cubic centimeter (70 times that of pure copper). The alloy is prepared in an oil furnace and then worked in the ordinary way by rolling

and drawing. Other valuable properties of the alloy are that it resists the action of moisture and is very acid proof; it is insoluble even in concentrated mineral acids; boiling strong aqua regia being required for its solution. The alloy withstands a red heat for a long continued service, and although under such conditions it oxidizes slowly, the oxide is coherent and does not materially change the conductivity.

Regulation of Polyphase Furnaces.—In operating an electric furnace with polyphase currents, it is important to see that the different phases carry equal loads, so as not to unbalance the supply system. If, for instance, a three-phase furnace is operated with three arcs, each playing between the end of three symmetrically arranged electrodes and the charge, then the charge represents the neutral point of the three-phase system. An additional neutral electrode may be placed in contact with the charge and connected with the neutral point of the supply system either directly or through the earth. If now three voltmeters are inserted between each of the three real electrodes and the neutral electrodes, then the readings of the three voltmeters will be equal, if the system is balanced. If the reading of one of the voltmeters differs from those of the other two, it indicates that the electrode conencted to the former carries either too much or not enough current. By adjusting the position of the electrode, the system may again be balanced. Of course, the indications of the three voltmeters may be made to act on an automatic regulating system which adjusts the position of the electrodes to keep the system balanced. In this arrangement the additional neutral fourth electrode is evidently an undesirable complication. Richard Fleming (904,194, Nov. 17, 1908; assigned to General Electric Co.) avoids it by establishing an artificial neutral outside of the furnace, which is "a counterpart or image of the interior neutral point." The outer end of each of the three electrodes is connected with an inductance coil, and the three free ends of the three inductance coils are connected together, the connection forming the artificial neutral point. The three voltmeters are now connected in parallel with the three inductance coils. Otherwise the arrangement is exactly the same as described above.

Phosphoric Acid from Phosphate Rock.—Fred. J. Maywald (902, 157, Oct. 27, 1908) produces phosphoric acid from aluminium phosphate, calcium phosphate, and mixtures of calcium, aluminium, and iron phosphates, all of which are relatively infusible. The finely pulverized phosphate rock, mixed with a trace of powdered carbon, is placed in a crucible, provided with two carbon electrodes, and heated to a high temperature, but below the melting point of the mass. Either a short arc is used (the voltage being from 40 to 60 at the beginning) or resistance heating is employed, the comminuted mass between the two electrodes acting itself as the resistor. When not heated to the melting point, but above the dissociation temperature of the phosphate, the mass remains in a porous condition, the phosphate dissociates and the P_2O_5 distils away leaving a residue of base or basic phosphates. The P_2O_5 is collected in a special condensing chamber. A slight amount of air is admitted to oxidize any phosphorus that may be formed; this air may be introduced through a slight space left between crucible and condensing hood. The P_2O_5 is condensed in form of a powder, which is readily soluble in cold water.

Zinc from Pyrites.—The problem of winning zinc from pyrite residues has attracted the attention of a German professor of physiology, Karl Kaiser (904,263, Nov. 17, 1908). He employs an electric furnace of pear-shape, the electrodes being introduced from the sides. The bottom of the furnace is perforated, these perforations being connected to a gas supply pipe to permit the admission of an oxidizing or a reducing gas into the furnace. The pyrite residue is introduced into the furnaces together with fluxes and the mass is heated. "As soon as the necessary temperature has been attained, i. e., in most cases the melting temperature of the mixture, an oxidizing gas such as atmospheric air is introduced into the heated mass, this oxidizing gas serving to oxidize all combustible impurities in the ore, the gaseous products resulting therefrom being led off from the furnace. When this stage of the process is complete, a reducing gas is introduced to the heated mass. For this purpose, gaseous carbon compounds and hydrogen can be employed. The most suitable for the process are carbon monoxide, water gas, and Dowson gas. The volatile metals escaping in gaseous form, for example, the zinc, are led out of the furnace and collected in a suitable receiver, where they are condensed in a known manner, and thus separated from any gases which pass out of them. The liquid constituents, for example, the iron, are led off from the lower part of the furnace and cast directly into ingots or bars. . . . By the mere roasting and reducing of materials such as contain zinc and iron with sulphur, it is impossible or only possible with great difficulty to separate the different metals completely from each other, for instance the zinc from the iron, the metals being in a fixed combination as in the state of an alloy."

The American Smelting & Refining Co.

Recent attacks, during the political campaign in Colorado, on the American Smelting & Refining Co. have produced an official reply by Mr. Franklin Guiterman, general manager of the Colorado district, from which we quote the following:

As to the price of lead, Mr. Guiterman says: "The American Smelting & Refining Co., large as it is, is and has been utterly without influence on the quotation applying to silver, copper and zinc. It has, as the greatest producer of lead in the United States, lent its sustaining influence to the maintenance of lead prices and to the extent which the company has been able to aid in the creation of better prices for lead, the lead producers of the United States have shared the benefit.

"The policy of the company with respect to the mining operators in Colorado has been one of consistent reduction in ore treatment charges as fast as improvements were introduced, which in the lowering of operating costs permitted such reductions to be made. In the policy which has actuated the company the salient principle has always been borne in mind to lend aid to such portion of the ore production which absolutely demanded it and to apply treatment charges on such other portions of the ore production which so far from hampering the output would, on the contrary, stimulate it to its utmost."

Mr. Guiterman points out the peculiar business of smelting of precious metal ores. "The industry is one which calls continually for a chemical adjustment of the ore charge and involves at the same time commercial considerations of greatest moment."

It is then emphasized that "it has been and always will be necessary to make such charges as will permit the greatest production of ores from all districts in order that the mining business may be stimulated to its highest degree and the maximum output obtained." For economy's sake works must be operated at nearly full' capacity, and "the basis of calculation has been the operation of all the works of the company under full capacity."

"The American Smelting & Refining Co. has no monopoly in its business. It has no secret process nor has it a monopoly of the technical and business talent which is necessary to successfully conduct its enterprises. It has no privileges in the matter of secret railway rates, and has constantly exerted its efforts with the railways for the obtaining of minimum freight charges, the benefit of which, when secured, has been given to the ore producer.

"The company has been charged with the new crime of employing brains in the conduct of its business. It pleads guilty to this accusation, but in doing so claims that it should and does have a keen recognition of the fact that being entirely dependent on the prosperity of the mining industry, it certainly cannot thrive in its downfall."

Dry-Blast Plant of the Illinois Steel Company's South Works.

The principle of the Gayley process is to cool far below its dew point the air required for the blast in blast furnaces and for the Bessemer process, and thus to deprive the air of the greater portion of its moisture. Its humidity is thereby rendered normal under any climatic or atmospheric conditions. The steam thus eliminated by condensation collects on the surface of closely packed groups of piping along which the air is sweeping, and which are kept at low temperature by circulating through them a refrigerated solution of chloride of calcium.

The arrangement of the cooling compartments or chambers, and the manner in which the pipe groups are mounted therein, are described in the following article, which treats of an installation recently completed at the South Works of the Illinois Steel Co., South Chicago, Ill. This plant is especially interesting, as the Gayley process is here employed, not only in connection with blast furnaces, but also in connection with Bessemer plant. This is the first application to a Bessemer plant, and has proved very successful.

The refrigeration of the circulating fluid is accomplished by machinery and apparatus furnished and erected by The

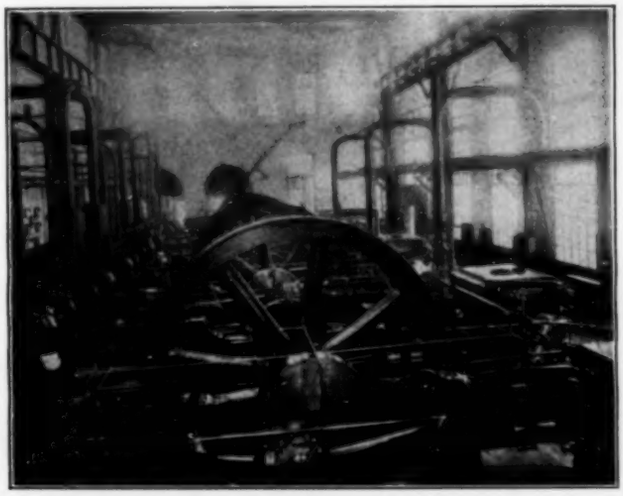


FIG. 1.—ENGINE ROOM IN SOUTH WORKS OF ILLINOIS STEEL CO. SHOWING FOUR 300-TON VILTER REFRIGERATING MACHINES.

Vilter Mfg. Co., 802 Clinton Street, Milwaukee, Wis. The entire plant is installed in structures especially provided for the purpose.

The main building, which is 102 ft. long and 53 ft. wide, accommodates on its first floor, which is 40 ft. in height, four refrigerating machines of 300 tons refrigerating capacity each (Fig. 1). They are of the duplex horizontal type, each machine consisting of a cross compound condensing Corliss engine and two ammonia compressors, placed opposite the high- and low-pressure steam cylinders, and connected to the crank disks on the ends of the common shaft. The size of the steam cylinders is 24 in. x 46 in., by 36-in. stroke, while the ammonia compressors are of 18-in. diameter and 36-in. stroke.

The Cooling Apparatus.—The ammonia compressors are provided with a set of two suction and two discharge valves, placed in each cylinder head and readily accessible. The gas discharged from the compressors passes through oil traps, of which one is provided for each machine and enters the condensers, which are placed on the second floor of the main building (Fig. 2). These condensers are of the double-pipe type, consisting of 2-in. pipes 18 ft. long, with 1¼-in. pipes passing through them for circulation of the cooling of condensing water.

Twenty-five stands of such double pipe condensers, grouped 12 pipes high, are provided for each machine, making in all 100 stands. While the division into four separate units is strictly maintained throughout for obvious reasons, yet connections and valves are arranged in such a manner as to permit

FIG. 2.—100 STANDS DOUBLE-PIPE AMMONIA CONDENSERS.

the operation of either two machines or all of them in combination on all or part of the ammonia condenser system.

The liquified gas is collected in four receivers located near the oil traps and carried through individual pipes to the cooling apparatus, in which the liquid ammonia is evaporated by means of the heat transmitted to it from the circulating fluid employed for the refrigeration of the vast volume of air supply.

The cooling apparatus (Fig. 3) is installed in a building 68 ft. 4 in. long, 58 ft. 8 in. wide and 25 ft. in height, which adjoins the engine room. The floor, walls and ceiling of this room are well insulated with a double lining of cork board, 2 in. thick. The coolers are of the double pipe type, and set in four batteries of 20 stands each. Each stand consists of

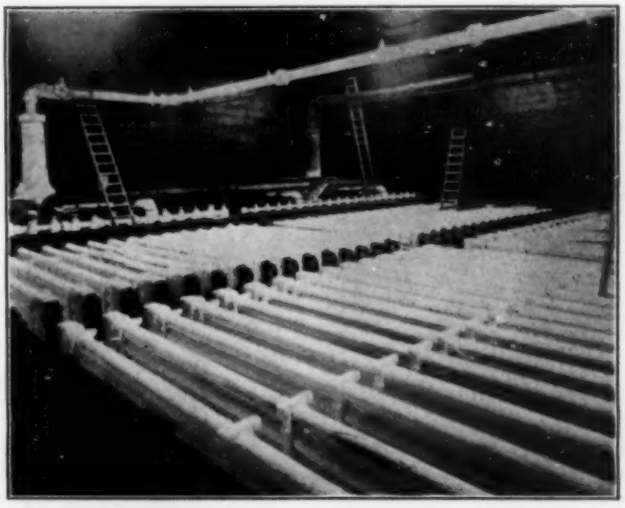


FIG. 3.—80 STANDS DOUBLE-PIPE BRINE COOLERS.

twelve 3-in. pipes, connected in circuit, and 2-in. pipes passing through them. A saturated solution of chloride of calcium, used as a circulating medium, is forced through the inner pipes and transmits its heat to the liquid ammonia contained in the annular spaces formed by the outer 3-in. pipes. By abstracting the heat from the circulating fluid, the liquid am-

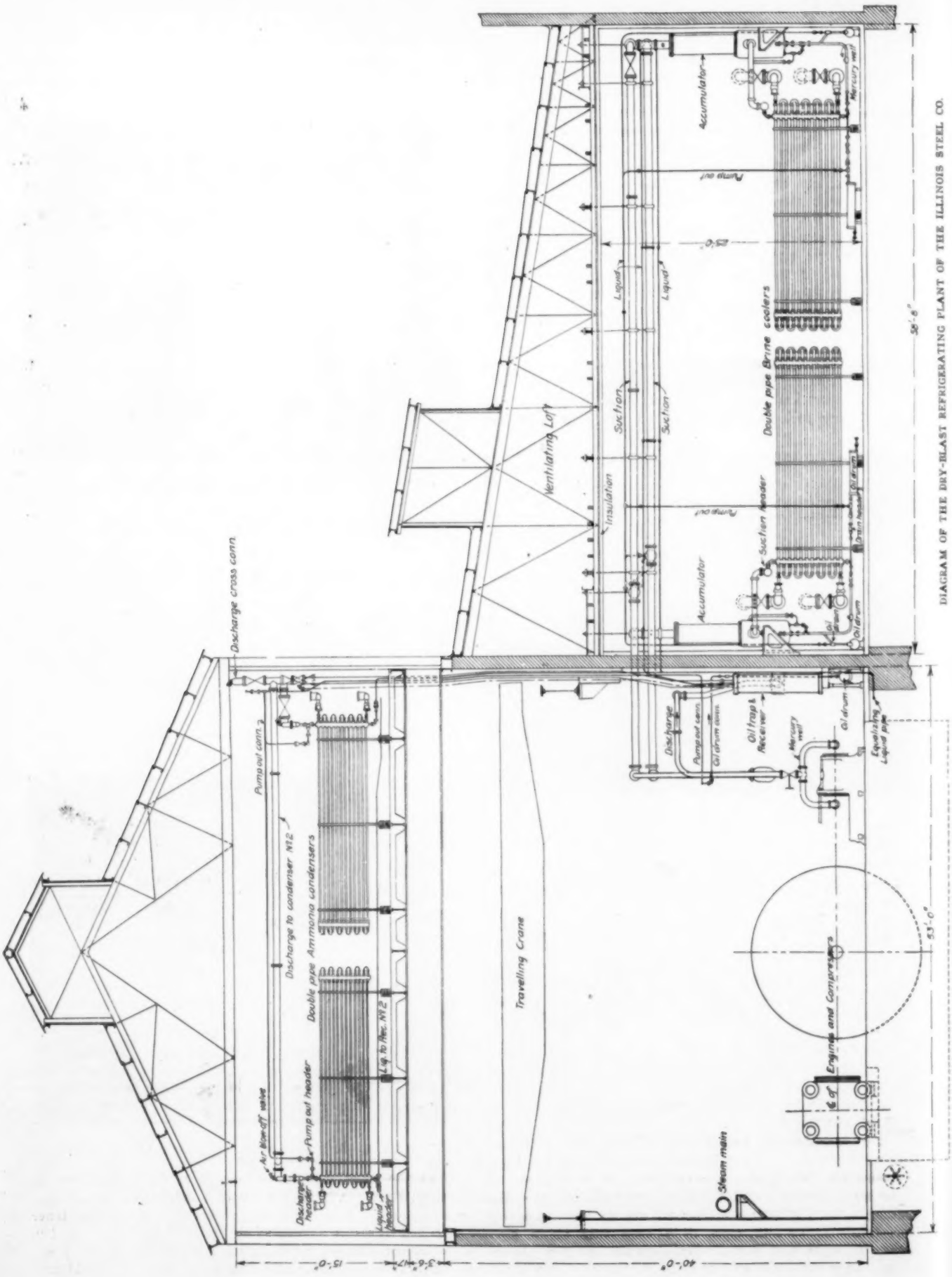


DIAGRAM OF THE DRY-BLAST REFRIGERATING PLANT OF THE ILLINOIS STEEL CO.

monia—the boiling point of which at the working pressure employed in the apparatus lies between 5 and 10 deg. Fahr.—is converted into steam or gas, which returns to the ammonia compressors to undergo again the process of liquid action.

The Method of Distributing Ammonia.—While the installation in its various parts barely presents any features which could not also be found in other modern applications of refrigerating machinery, it is the method in which the liquefied ammonia is handled and uniformly distributed to the great extent of the cooling apparatus which deserves special mention.

In usual refrigerating practice this is accomplished by needle valves or expansion cocks attached to the supply side of each stand of the cooling apparatus, and by which it is attempted to regulate the supply of the liquid refrigerant as it comes from the ammonia condensers so accurately that each stand receives its requisite amount of ammonia; that is to say, no more nor less than such an amount as can be converted into steam or gas by the heat transmitted to it from the entire heating surface of each stand, which is the aggregate area of the outer pipe surface of the 2-in. pipes of each cooler. Unless this condition is fulfilled there will be either a portion of the heating surface left ineffective for lack of liquid ammonia to which the heat can be transmitted, or more or less of the refrigerant will pass through the cooling apparatus in liquid state and return to the compressors, curtailing the capacity or efficiency of the latter.

As the referigerating process is in principle nothing but a process of evaporation, where a fluid of very low boiling point (liquid anhydrous ammonia boiling at 29.6 below zero F.) is converted into steam by the heat transmitted to it from a fluid of a temperature higher than this boiling point, practically the same course is adopted in the refrigerating apparatus of the Illinois Steel Company's dry blast plant as that pursued in the universally known evaporating apparatus; namely, steam boiler practice.

How the Cooling Process Parallels Steam Boiler Practice.—The heat extracting (cooling) apparatus as built by The Vilter Mfg. Co. under its patent 894,285 of July 28, 1908, may be compared with any of the familiar types of horizontal water-tube boilers, in which a group of tubes is connected to front and rear water legs carrying a common steam drum in which the steam separates from the entrained water as follows: From an elevated receptacle called the accumulator, which is partly filled with liquid ammonia, the latter flows through a large pipe (the rear water leg of the boiler) communicating with the inlet ends of all double pipe coolers into the annular spaces (the tubes of the boiler) formed between the inner wall of the 3-in. pipes and the outer one of the 2-in. pipes passing through them. Here it is subjected to the effect of the heat transmitted through the walls of the 2-in. pipes by the circulating chloride of calcium solution (the fire and combustion gases of the boiler furnace) and converted into gas (steam). The gas and entrained liquid ascend and reach another large pipe header (the front water leg of the boiler) connecting all the outlet ends of the double pipe coolers through which they enter the accumulator (steam drum of the boiler).

In this drum the separation of gas and entrained liquid takes place, the gas passing out on top through the main suction line to the compressor for reliquefaction, the liquid returning from the lower end of the accumulator to the double-pipe coolers for renewed circuit.

It is evident that through the adoption of this method of introducing the liquid refrigerant into the evaporating apparatus only one supply valve is needed for each battery of 20 coolers or for all four batteries if it were not for the demanded division into four separate units in this case—in the same manner as a great many boilers may be supplied by one boiler feed pump. It is also evident that through this flow by gravity through a communicating pipe the liquid refrigerant is distributed to all coolers alike in such quantities as will not only suit the varying conditions of temperature of the circulating and heat transmitting fluid, but also insure the full use of the total evaporating surface of each cooler.

Making the Cooling Process Continuous.—To make the cooling process continuous, the ammonia gas generated in the coolers is returned to the accumulator after being reliquefied by means of compression and subsequent condensation. In doing so, however, one important feature upon which hinges the success of the entire procedure has to be observed. The process of liquefaction must necessarily be performed at the temperature of the cooling water which is available for the ammonia condensers. The liquefied ammonia returning from the condensers to the accumulator is therefore of much higher temperature and under much greater pressure than are maintained in the evaporating or cooling coils of the apparatus.

If the liquid refrigerant were liberated in this condition from the high pressure under which it is delivered from the condenser, its sensible heat at the high temperature corresponding to that pressure would be consumed at once in converting a part of such liquid into gas. This partial conversion into gas of every particle of the fluid would be an instantaneous, flash-like one and would not only cause the loss for effective refrigeration in the cooling coils of this portion of the fluid, but also a disintegration of the compact flow of the liquid in the same manner as if water is blown from the test cocks of the water column of a boiler under high steam pressure or as it emanates from the blow-off pipe. This spray of liquid would be carried along with the current of gas flowing from the accumulator to the compressors, and, becoming unavailable for evaporation in the coolers, constitute a much greater loss in efficiency than the one alluded to heretofore.

To prevent this loss it is necessary to deprive the liquid refrigerant of its excess of sensible heat before it is relieved of its high pressure and admitted into the accumulator. This is accomplished by the use of a long spiral coil suspended in the upper part of the accumulator and exposed to the current of the cold gas flowing to the compressors through which the liquefied ammonia passes before it reaches the relief valve which supplies each battery of coolers.

The machinery installation was commenced the middle of March this year, and was completed May 5. It proved successful from the beginning and has been operated throughout the summer, exceeding in its performance by far the guarantees to which the builders, The Vilter Mfg. Co., had submitted in their contract with the Illinois Steel Company.

Condensing of Nitric Acid.

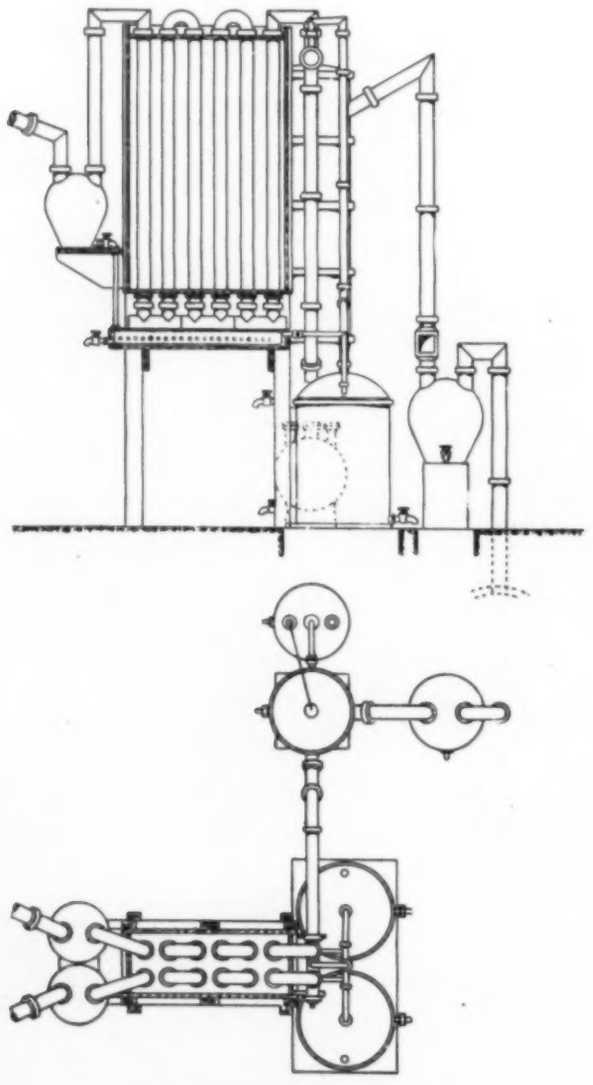
In the following we give a description of the latest form of condensing battery for nitric acid, invented by Mr. Oscar Guttmann, and made by the Didier-March Co., of New York City. The large new works of this company in Keasby, N. J., where chemical stoneware, apparatus and appliances are made for all purposes of the chemical and metallurgical industries, were described in our last issue.

The operation of Guttmann's new condensing battery for nitric acid is as follows: The gases on issuing from the still are rapidly condensed in a receiver and six long, water-cooled stoneware pipes with thin walls at such a temperature that a minimum amount of water contained in the gases is separated while the nitrous acid and chlorine remain in the gaseous state. These gases pass through the battery to the absorption tower, the temperature in which is so regulated that the chlorine and part of the water are driven off. The nitrous acid, however, is almost completely oxidized to nitric acid in its passage through the battery to the tower by a current of air which is simultaneously injected.

In order to obtain these results it is necessary that after condensation the nitric acid is rapidly removed from contact with

the uncondensed gases. For this purpose drain pipes are attached to the lower ends of the connecting elements, leaving a free passage for the gases. The drain pipes dip into the acid, which collects in a tubular cooling channel before running into the storage vessel; any gases evolved in this being conducted to the tower.

If it be desired to thoroughly "bleach" the acid, a little compressed air, which has been heated by an iron coil placed in the flue of the still, is blown into the storage vessel. When bleaching in this way the cooling water in the cooling channel has to be so regulated so as to be at a temperature of at least 50° C. on leaving the cooler.



NITRIC ACID CONDENSING PLANT.

A battery of six pipes can readily condense the distillate obtained from a charge of 2000 lb. The whole of the acid produced is of one strength only, so that no further blending is necessary. The acid when collected in the storage vessel is at such a temperature as not to irritate the workmen while drawing it off.

Guttmann's condensing battery may be used for the manufacture of nitric acid of any desired strength by charging the tower acid again into the still and recovering it as strong acid at the next distillation.

The acid produced with Guttmann's battery is nearly chemically pure; it is free from chlorine and sulphuric acid, and only contains small quantities of nitrous acid. Nitric acid of 96½ per cent (specific gravity 1.507 = 48.4° Baume) contains about 1 per cent of HNO_3; acid of 1.420 specific gravity (42.7° Beaume) only contains traces.

The usual charge for a still is 2000 lb. of 96 per cent nitre. For the production of highest-grade nitric acid, 2420 lb. of sulphuric acid containing 94½ per cent monohydrate (1.838 specific gravity) are required; for the production of nitric acid of 1.420 specific gravity (42.7° Baume), 2536 lb. of sulphuric acid of 79.36 per cent, or 1.725 specific gravity, are required.

Waste acid, such as that from the manufacture of gun cotton, may be used, and the nitric acid contained therein recovered as strong acid. The yield is in every case between 99 and 99½ per cent of that theoretically possible without the production of any weak acid of inferior value.

The coal consumption is 250 lb. per charge of 2000 lb. of nitre. The distillation takes about 10 to 11 hours; charging, emptying and drawing off require another two hours. The quantity of compressed air required for bleaching is about 100 cu. ft. at 45-lb. pressure per charge, and the consumption of water is 450 to 650 gal. Three men can easily work eight stills, two men four stills, while one man and an occasional helper are required for two stills.

With Guttmann's battery one can, of course, distil weak nitric acid by mixing it with sulphuric acid of 1.840 specific gravity and distilling in suitable stills. A uniform acid containing 96 per cent nitric acid can hardly be obtained when distilling in cylinders as too much cooling takes place at the ends, and stills are required which are surrounded on all sides by the flue gases. A good absorption tower, like a Guttmann ball tower, is another condition; one of 2 ft. 4 in. diameter is sufficient for four stills of 2000 lb. each. The cost of repairs are trifling.

Guttmann's batteries are usually made in double sets, as shown in Fig. 1, so that twice six pipes are mounted in one water tank. If the tower attached to such a double battery is 2 ft. 4 in. in diameter and 10 ft. high, a second double battery may be connected to it.

The following table gives some figures concerning the charges and yields:

Manufacture of Nitric Acid from	Charge	Yield	Coal Consumption	Wages	Space Occupied
Nitre and strong sulphuric acid.	2,000 lb. of 96% $NaNO_3$, 2,420 lb. of 94.5% H_2SO_4.	1,644 lb. HNO_3 of sp. g. 1.504, i.e., 99% of the theoretical.	2½ cwts. per 20 cwts. of nitre.	3 men for 8 stills.	About 65 sq. ft. for two batteries, depending on the arrangement.
Nitre and weak H_2SO_4.	2,000 lb. of 97% $NaNO_3$, 2,536 lb. of 79.36% H_2SO_4.	2,397 lb. HNO_3 of sp. g. 1.420, i.e., 99.4% of the theoretical.			
Nitre and waste sulphuric acid. (Yearly average of a government factory.)	2,000 lb. of 96% $NaNO_3$, 585 lb. of 96% H_2SO_4. Waste acid containing— 10% HNO_3 80% H_2SO_4 10% H_2O } 2,052 lb.	1,854½ lb. HNO_3 of sp. g. 1.506 = 96.5% of the theoretical.			

Girod Steel Process.

In connection with the description of the Girod electric steel furnace in our October issue (page 428) it is interesting to note that this furnace has recently been adopted by the following concerns:

Ste. An. John Cockerill, Seraing, Belgium, who have taken out a license for the installation of a three-ton furnace, to be worked in conjunction with their Martin or Bessemer steel furnaces for the making of structural steels.

Ternitzer Stahlwerke, von Schoeller & Company, in Ternitz, Austria, who are likewise installing a two-ton furnace on the Girod system to replace their crucible steel plant.

Oehler & Co., in Aarau, Switzerland, and Storz & Co., in Stuttgart, Germany, who are each fitting up a two-ton furnace, intended solely for the manufacture of steel castings. The

plant of Oehler & Co. was described in our November issue, page 452.

The Girod furnace has been used in the past at the works of the Société Anonyme Electrométallurgique, Procédés Paul Girod, Ugine, Savoy, France, for the manufacture of various special steels, not only carbon steels, but alloy steels. It is thought that the Girod furnace "is particularly adapted to the manufacture of case-hardening steels, owing to the fact that the action of the air is avoided, and that a sound non-oxidized metal can be cast without having recourse to excessive additions of manganese and silicon. After case-hardening, therefore, the central part remains highly fibrous, and the very hard surface has no tendency to splinter. Thus, an impression with the Brunnel ball, 10 mm in diameter, with a pressure of 3000 kg, shows no cracks on the edges."

Some interesting notes on steels which have been made commercially in the Girod furnace, with the result of tensile tests, are given in a pamphlet recently issued by the representatives of the Girod process in this country, C. W. Leavitt & Co., 220 Broadway, New York City.

List of Heroult Furnaces.

The list of European Héroult furnaces, reproduced on page 469 of our last issue from *Stahl und Eisen*, is somewhat incomplete. We herewith give a corrected complete list, comprising both European and American Héroult furnaces:

	Finished, kilograms.	Under construction, kilograms.
1. Stahlwerke Richard Lindenberg, Remscheid-Hasten, Germany	3,000	....
2. Stahlwerke Richard Lindenberg, Remscheid-Hasten, Germany	1,800	....
3. Stahlwerke Richard Lindenberg, Remscheid-Hasten, Germany	500	....
4. Bismarckhütte, Bismarckhütte, Upper Silesia, Germany	3,000	....
5. Bismarckhütte, Bismarckhütte, Upper Silesia, Germany	1,000	....
6. Bismarckhütte, Bismarckhütte, Upper Silesia, Germany	*....	*....
7. Deutsche Mannesmann-Röhren Werke, Saarbrücken, Germany	*....	*....
8. Kaernthner Eisen & Stahl Werke, Austria	*....	*....
9. Deutsch - Oesterreichische Mannesmann - Röhren Werke, Burbeck	....	3,000
10. Danner & Co., Judenburg, Austria	2,000	....
11. Gebr. Böhler & Cie., A. G., Kapfenberg, Austria	2,500	....
12. Gebr. Böhler & Cie., A. G., Kapfenberg, Austria	*....	*....
13. Georg Fischer, Schaffhausen, Switzerland	1,000	....
14. Georg Fischer, Schaffhausen, Switzerland	....	5,000
15. Georg Fischer, Schaffhausen, Switzerland	....	5,000
16. Soc. Electromet. Française, La Praz, Savoy	3,000	....
17. Acieries du Saut du Tarn, St. Juery, France	5,000	....
18. Aktiebolaget Héroults Electriska Stal, Kortfors, Sweden	4,500	....
19. Halcomb & Co., Syracuse, N. Y., U. S. A.	5,000	....
20. The Firth-Sterling Steel Co., McKeesport, Pa., U. S. A.	3,000	....
21. Societa Tubi Mannesmann, Dalmine, Italy	....	6,000
22. Societa Tubi Mannesmann, Dalmine, Italy	....	6,000
23. Edgar Allen & Co., Sheffield, England	....	3,000
24. Edgar Allen & Co., Sheffield, England	*....	*....
Total	35,300	28,000

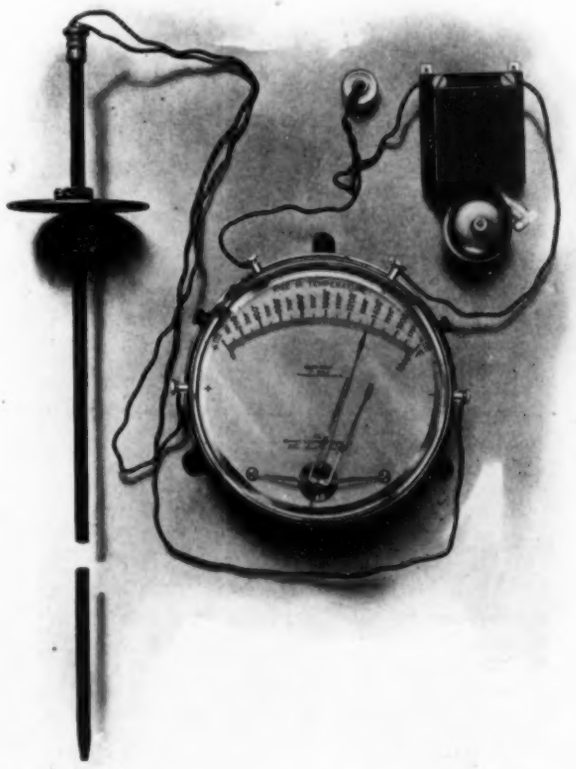
*Size and number not yet determined.

No. 6, contemplated by Bismarckhütte, will be a large furnace, but the exact size has not yet been fixed. The Austrian Mannesmann Co. is building a 3,000-kg furnace (No. 9); the size of the furnace to be erected by the German sister concern (No. 7) has not yet been determined; two 6,000-kg furnaces are under construction by the Italian Mannesmann Co.; size of No. 12, to be erected by Gebr. Böhler, has not yet been determined.

The Alarm Pyrometer.

The accompanying illustration shows the latest form of the Advance electric pyrometer, the purpose of which is to give an alarm when the temperature of the furnace to which the apparatus is applied falls out of the desired range of temperature within which it is intended that the furnace be operated. It serves a purpose that a simple indicating instrument or a recording instrument cannot exactly accomplish. In a great deal of work there is not only one temperature that is desired, or at least that it is possible to continuously maintain, but there are certain upper and lower limits between which the work should be done and this alarm pyrometer gives timely notice when either of those limits is being approached. It, therefore, is not only a check upon the furnace man in the sense of being a tell-tale if his temperatures vary too greatly, but it is a genuine aid to him in that it calls his attention to the improper tendency of the temperature of the furnace in time to rectify matters.

Little need be said as to the operation of the pyrometer, for it is simply a thermoelectric pyrometer, but it should be pointed out that the electric current from the fire-rod (thermocouple) is wholly independent from the electric current that operates the alarm bell. The latter is supplied from batteries or house circuit, which passes through the indicating hand of the gauge and through whichever of the contact fingers that indicating hand may touch.



ALARM PYROMETER.

Good electric contact is insured by the two iridium points on the indicating hand and the two carbon tips on the fingers. The position of the two alarm fingers may be instantly adjusted and, of course, when the indicating hand moves within the limits set by them and not touching either, the bell is not sounded, but instantly upon contact with one or other fingers, notice is given by the alarm bell that attention to the furnace temperature is required. By throwing the alarm fingers, one or both, outside of the range of the instrument, the pyrometer becomes an alarm instrument for one instrument only or a simple indicator. Good electrical contact is insured between the indicating hand and the alarm fingers, as the bell works on 110 volts.

This alarm pyrometer is the principal feature of the new complete pyrometer catalog just issued by the Wilson-Maeulen Co., of 1 East Forty-second Street, New York City.

Plating Rheostats.

The Ward Leonard Electric Co., of Bronxville, N. Y., have designed a complete line of plating rheostats, both for field and line control. Fig. 1 shows the "field rheostat" with special circuit-breaker. If an article is to receive a plating of certain weight, it is suspended on a balanced beam in the plating tank. When the weight has been deposited, the beam falls, the circuit-breaker operates, and the circuit is broken.

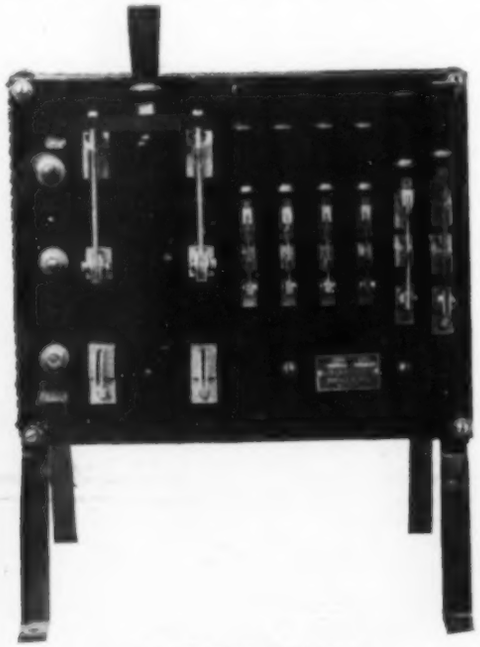


FIG. 2.—LINE RHEOSTAT.

Fig. 2 shows the "line-control rheostat." This is a unique and new design for this apparatus and offers great possibilities. It is designed for single-voltage and double-voltage control. The illustration shows a double-voltage type to be used on a 5- and 10-volt circuit, i. e., either on one leg of a three-wire circuit having 5 volts on each leg, or upon the total 10 volts. There is a plain line switch (fused when so desired), which closed in one direction gives any amperes from 1 to 40 amp on 10 volts, and when closed in the opposite direction gives 80 amp on 5 volts. This gives 31 steps of control on either voltage. Each switch, with its resistance, is designed to be connected across the full 5 or 10 volts, respectively. The various numbers of steps are obtained by using the switches singly or in parallel. As the resistances are designed for the maximum voltage that can be applied upon them, "burn-outs" are impossible. These rheostats are designed for any capacities and voltages.

Concentration.

While, in general, for the concentration of crushed ore a series of operations is required which are carried out in different machinery adapted for "preliminary separation" and for "final separation," respectively, the object of the Woodbury system of concentration is to eliminate largely preliminary separation by means of classifiers, screens, etc., and to combine into one the classifying and jigging operations.

The concentration is carried out in a series of jigs, of which the first is the feature of the system, being a combined slime classifier and jig. It treats an unclassified or mixed feed, not coarser than three-eights of an inch, and including slimes, performing the regular functions of a jig by making a clean cup and hutch concentrate and at the same time effecting an absolute separation of slimes from the jigging material, with little or no dilution of the slimes.

This classifying jig is shown in Fig. 1. It is built with a plunger compartment at the head of the machine, in which a plunger is actuated by means of eccentrics. A differential motion of the eccentrics results in a quick downward and slow upward motion of the plunger. The charge is delivered at the head of the machine and flows over a sieve of suitable mesh, supported on sieve bars. The action of the plunger imparts a differential pulsation to the water up through the sieve bars. The pulp flowing over the sieve is lifted sharply by the pulsation and allowed to descend naturally, or, in other words, by gravity, resulting in its thorough stratification, heavy mineral settling to the bottom, then middlings, sands and slimes. There are four discharges from the classifier: the slime 2, approximately 60 mesh and finer; the tail product 3, which is usually re-treated on the following jigs; the coarse cup concentrates 4; and the fine or hutch concentrates 5.

The slime-classifying device consists of a large brass shield, adjustable vertically, and so set that the pulp on the sieve effectually seals it against the entrance of slimes. The pulp falling onto the sieve is subjected to the jigging action, the light particles or slimes being scrubbed out of the gravels and sands and held in suspension by the hutch water from below. The suspended matter, or slime, is carried around this shield, over the tailboard and away for further treatment. By regulating the height of the tailboard, the mesh of the particles, separated as slimes, can to some extent be governed.

The pulp moving on the sieve bed is drawn along inside the shield toward an opening or slot, somewhat lower than the slime discharge. This opening is controlled by a gate and is

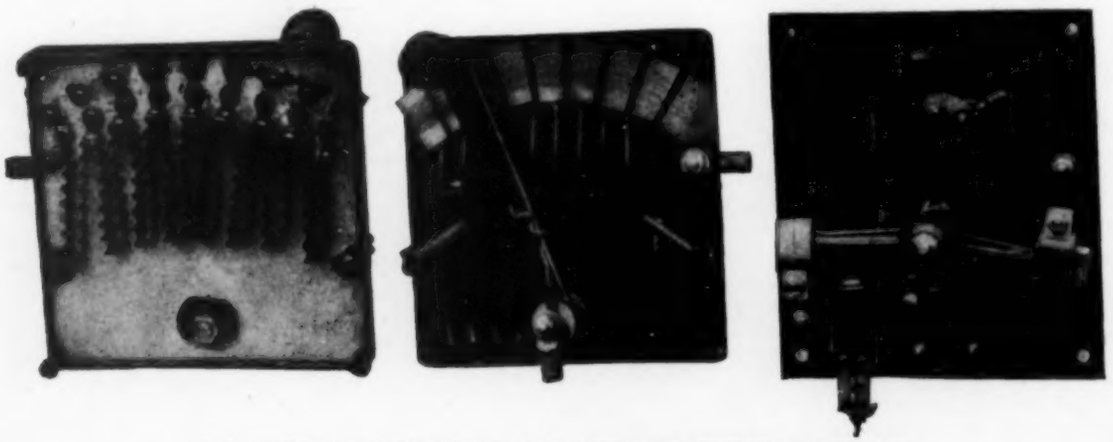


FIG. 1.—BACK AND FRONT VIEWS OF FIELD RHEOSTAT WITH CIRCUIT- BREAKER.

regulated to suit the quantity of feed to be treated. The height of this opening regulates the depth of the sieve bed, and is determined once for all time. The discharge of the pulp from the slot, having been subjected to the jigging action, constitutes a retreating middling, which is usually cleaned up on the subsequent jigs.

Another brass shield inside the large slime shield constitutes a cup for the drawing off of coarse concentrates. This cup extends down and into the bed of concentrates, and discharges the same through a pipe and away from the machine. From the hutch plugs of the classifier is drawn a large volume of clean, fine concentrates, which have jigged through the sieve bed into the hutch.

The body of the machine is built of cast iron, being a one-piece casting, strong and substantial, with all discharges conveniently located. Double eccentrics are fastened to shaft and are graduated for ready adjustment to different strokes; bearings are babbitted, and have ample oiling facilities. The quick

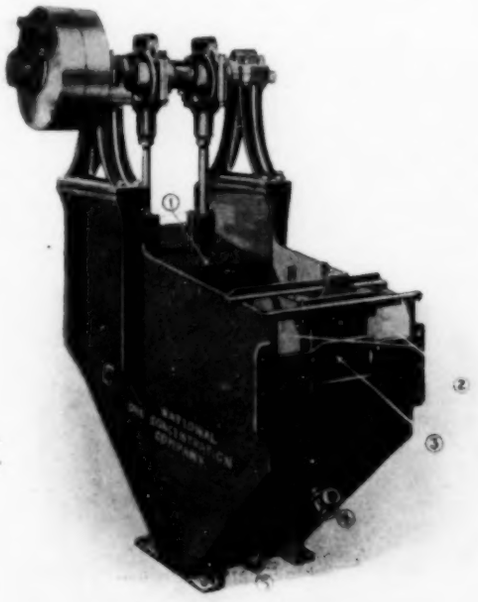


FIG. 1.—CLASSIFYING JIG.

return motion consists of a variable crank connection, between driving pulley and shaft; all wearing parts are of brass and can be taken up for wear as necessary.

As already mentioned the slime-classifying jig is usually followed by one or more compartments of Woodbury jigs to complete the separation of "concentrates," "middlings" and "tailings" as required.

The Woodbury jig is constructed with plunger compartment at head of jig. The feed flows on at head end and over the plunger compartment. The pulsations produced by the plunger are in line with the flow of pulp, instead of at right angles, resulting in an absolutely uniform pulsation the entire width of sieve and making an excellent stratification.

An important feature of the jig is the water lessener, a device for diverting the excess water of the feed into the hutch of the next succeeding jig. The pulp flows into a compartment from which it is discharged through plugs, over plunger compartment and on to the next sieve. The surplus water flows over top of lessener into a trough, communicating with the hutch under plunger, thus effecting a very material saving in hutch water as well as reducing quantity of top water, which otherwise accumulates and tends to carry off light values.

The discharge of concentrates from the sieve is accomplished by means of brass cups, which are located near the tail of the jig, and so placed that they will draw on bed of the concentrates equally from both sides. The cup extends into the concentrate bed, which seals it against the entrance of low-grade material. Concentrates are discharged from the cup by an adjustable brass discharge, the height of which controls the depth of concentrate bed on sieve, which in turn controls the quality of hutch product discharged by means of plugs.

The middling jigs are equipped with an efficient device for discharging middlings, viz., the hydraulic middling discharge. An angle iron shield is fastened across the tail of the jig, extending down into the middling strata, which seals it against the entrance of tailings. From under the shield a number of openings, placed at intervals of 6 in., lead into a hydraulic compartment. A fresh water supply therein, regulates the quantity and quality of middlings discharged from under shield through these openings, into this compartment, and out through plugs, in the bottom. The tailings from one jig pass over angle-iron shields and hydraulic compartment to water lessener of next succeeding jig. The advantages of this device are a uniform discharge over the entire width of the jig and the separating of a true middling by holding back the light mineral and tailings with hydraulic water.

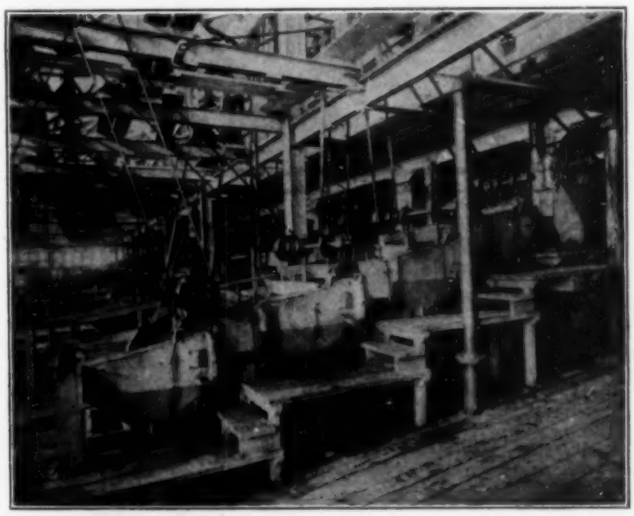


FIG. 2.—CLASSIFYING JIGS AT CALUMET AND HECLA PLANT.

Fig. 2 shows an installation of the Woodbury slime classifier and jigs at the Calumet and Hecla Mining Company's plant at Lake Linden, Mich. At these mills 28 sections are now equipped with the Woodbury machines and six years of continuous service have thoroughly demonstrated their economic value. In these mills a 3/16-in. feed, including slimes, is treated, the slime classifier separating the slime so dense that it goes direct to tables for treatment without being thickened. High-grade concentrates are made and the values lost in tailings have been very materially reduced.

The Woodbury jig is built by the National Ore Concentration Company, 1730 First National Bank Building, Chicago, Ill.

Electric Time Recorder.

Bristol's new electric time recorder (Fig. 1) was designed to meet the widespread demand for a simple and practical instrument to record automatically the occurrence and duration of various operations, such as the starting and stopping of machines, the opening and closing of valves, the duration of runs, etc. It may be used to advantage in connection with gas producers, Bessemer converters, for recording the charging and discharging of coke ovens, etc. With Bristol's electric time recorder it is possible to record several different operations on the same chart and the recorder may be located a long distance from the points at which such operations occur.

These new Bristol recorders have already been used in connection with machinery to show when the machines were started and stopped, how long they remained idle, and just when they were started again. Fig. 2 is a reduced cut of a record chart giving a complete 24-hour record of the operation of two paper machines. This record shows the time and duration of each break and also the time required to wash the felts and put on new wires.

FIG. 1.—ELECTRIC TIME RECORDER.

One of these recorders arranged to record operations at six different points is shown in Fig. 1. Each one of the six pens shown on this instrument makes an independent record, continuously and automatically, and in this way six different operations may be recorded on the same chart. Each pen is actuated by an independent electromagnet and battery-circuit, so arranged that closing the circuit causes the pen to move a certain distance on the chart.

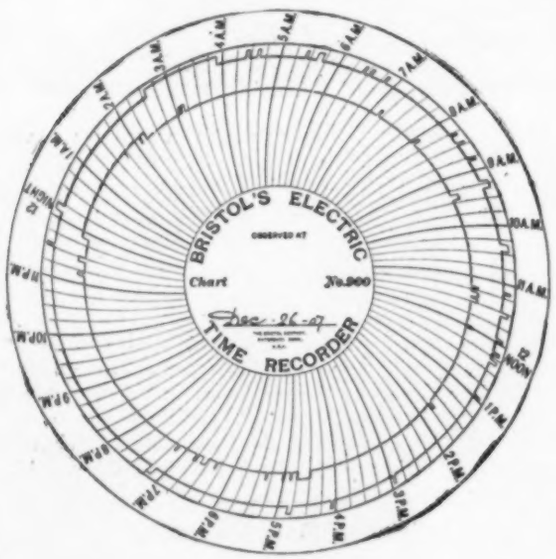


FIG. 2.—RECORD CHART.

Binding posts are provided at the base of the recorder, to which pairs of small lead wires are attached. These wires may be of almost any desired length, it only being necessary to have the object whose motion is to be recorded open or close the circuit whenever the motion occurs.

These recorders are usually operated by a battery circuit, but any convenient circuit may be employed by the insertion of lamps or other resistance to reduce the e.m.f. across each electromagnet. The object whose motion is to be recorded is caused to make and break this circuit through any convenient contact.

The Bristol Co., Waterbury, Conn., are the manufacturers of these recorders.

Dry Concentrating Table.

A successful dry concentrating process has, in comparison with wet concentration, that evident and very important advantage that the concentrating mill can always be installed right next to the mine, so that the ore has not to be transported to some place where sufficient water is available. Naturally attempts to design a reliable dry concentrating table have been many.

In his suggestive and interesting presidential address of last year before the Western Association of Technical Chemists and Metallurgists, Mr. W. G. Swart made the following remarks concerning dry concentration:

"As to dry concentration of ore some facts have now been more clearly established than ever. First, dust cannot be concentrated and must be removed. Second, sizing must be very much closer than for wet concentration, which brings up the screening problem. Third, the active body of air must be divided up into small sections, since it is not practically possible to handle ores in large masses continuously, as, for example, on the Hartz jig. Finally, the dry mill has a labor problem of its own, since the ordinary millman does not understand clearly the underlying phenomena."

With respect to these requirements it is interesting to describe the Behrend dry concentrating table, made by the Behrend Dry Concentrator Company, 10 Wall Street, New York. Perhaps the most significant fact in connection with it is that the labor problem of the dry concentrating mill appears to be solved. As will be seen from the following description, the adoption of the air-suction or exhaust principle instead of air blast has resulted in such a simple construction that any ordinary millman or boy can adjust the table. It only requires eyesight, not any special skill or knowledge. Moreover, the exhaust principle makes the operation naturally dustless.

The accompanying illustration shows the construction of the Behrend table. The air enters at *A* and is forced to pass between the table, provided with riffles, and the top glass plate above. The air suction is produced by a fan, the driving axle of which is shown at *B*. In the latest design a sirocco fan has been adopted. The ore is fed through the hopper *C*, and by means of a continuous vibratory movement of the table (the driving axle of the mechanism being shown at *D*) the ore is moved down the table, while being thoroughly moved and agitated. The air current (moving in the direction opposite to that of the core) meets the ore. The heavier metal particles remain on the dressing table and pass down toward *A*, while the lighter gangue matter and dust are taken up and along with the air current.

There are two types of the Behrend table. In one the riffles on the dressing table are perforated and the lighter gangue and dust particles are carried together with the air downward through the riffle perforations. In the other type the riffles are not perforated and the lighter gangue particles and dust are carried along by the air current to a discharge at the back.

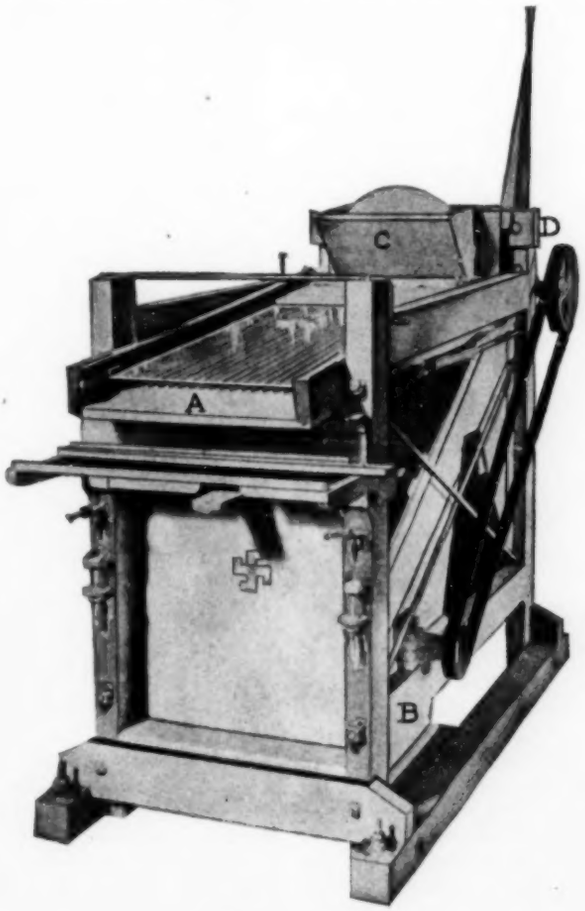
The heavier metal particles, therefore, pass out at *A*. The lighter gangue matter is taken by the air current down into the base of the concentrator onto baffle boards, and when sufficient weight has accumulated, an outlet valve opens and discharges the tailings. The dust is carried on through with the exhaust air into a special dust chamber, where it is collected.

The capacity of the standard Behrend table is from 8 to 15 tons in 24 hours, according to the sizes treated. The weight

of the concentrator is 500 lb. The floor space is 3½ ft. x 6 ft. The power required is said to be now less than ½ hp.

The table appears to be well designed. The width of the table seems to be just of the right dimension to enable thorough control of the air current. This control is, of course, also aided by the riffles.

The adjustment of the table is exceedingly simple. The amount of material charged through the hopper can, of course, be easily regulated. More important is the adjustment of the air current. Since the fan runs at constant speed, the regulation of the air current must depend on a regulation of the air supply, and this is accomplished by raising or lowering the top plate above the dressing table. This is done by a little wheel (only slightly indicated in the illustration). The operator, while turning the wheel, watches the discharge until his eyesight tells him that the discharge of concentrates is right. The table is then adjusted, once for all, as long as the charge does not vary; and it is clear that a boy should be able, with a little experience, to attend to a large series of dressing tables. The only important thing to look after is that the concentrates are discharged in clear condition and in proper volume.



DRY CONCENTRATOR.

The success of the concentrating tables depends, of course, on the proper condition of the charge. The ore must be fairly dry, crushed, pulverized and screened to correct sizes, according to the condition of each case. Mr. Samuel K. Behrend, the inventor of the concentrating mill, has therefore also designed a continuous ore drier and a pneumatic sizing screen, the latter being also operated on the exhaust principle.

As an example of the work of the Behrend concentrating table it is stated that when "working on a complex ore, favorable to concentration, containing 9 per cent lead, 12 per cent zinc, the remaining constituents being iron and silica, the result is 70 per cent lead concentrates, the iron carrying less than 1 per cent lead and about 3 per cent zinc, and the zinc product was brought up to 40 per cent."

A testing plant under the Behrend system is maintained by Messrs. Hy. E. Wood & Co., of Denver, Col. In New York City, Behrend testing tables are shown in operation at the Shippers' Exchange, Twenty-second Street and Eleventh Avenue.

Buying on Chemical Specifications.

Where dimensions, weight, finish and the like may be readily expressed in specifications, it is easy and natural to make them conditions upon which purchases shall be accepted. But where strength, chemical composition, durability and similar factors of ultimate efficiency are of importance, specification of these features is all too often omitted.

The reason is obvious; tests must be applied which usually call for equipment, knowledge and experience beyond those possessed by the average buyer. He is then obliged to turn to the expert, but objects because of the initial expense and fails to recognize the ultimate economy.

In every industry some material is being bought on the basis of brand, reputation or even satisfactory experience in its use without the least idea that equal efficiency might be obtained at a lower price with a suitable material whose composition could be specified in advance by the chemist. But where the purchaser is alive to all such savings they may be made to aggregate a considerable net amount after all expert service is paid for. The following experience is suggestive:

The purchasing agent of a large electric railway company was recently buying of a reputable supply house a metal for journal linings, which gave good satisfaction. He was paying 20 cents a pound, and, in view of the nature of the material, felt that the price was high. A sample was submitted to the Arthur D. Little Laboratory, in Boston, for analysis. Upon receipt of their report, the purchasing agent sent out for bids upon a metal of the composition shown on analysis. A reliable concern at once offered such a metal at 6 cents per pound. As the amount of metal used in a year was large, the saving by having the same metal made to their formula was well worth obtaining.

Notes.

The Chemists' Club of New York City has celebrated the tenth anniversary of its birth on Nov. 21 with a dinner in the lecture hall of the club.

Alcohol from Natural Gas.—The Continental Natural Gas Alcohol Co., of Wheeling, W. Va., has been formed to make installations for the manufacture of industrial (denatured) alcohol from natural gas, under the patent of Mr. Carl von Hatzfeld. We intend to describe the process in our next issue. It is stated that 5000 cu. ft. of natural gas will produce about 50 gal. of alcohol.

Tested Reagents.—We have received from Messrs. Merck & Co., of New York City, a copy of their "Prices and Uses of Tested Reagents—1909." Merck's reagents are submitted to the tests described in the well-known book, "Chemical Reagents, Their Purity and Tests," published by Van Nostrand Co. in 1907. Merck's tested reagents are indicated by a blue label, to distinguish them from Merck's photographic, medican and technical chemicals.

The Salt Lake Hardware Co. of Salt Lake City, jobbers of iron, steel, metals, mine and mill machinery, assayers' supplies, etc., are proceeding rapidly with the construction of their new warehouse, which is expected to be the finest warehouse in the entire intermountain country. They are also preparing their new hardware catalog, which will contain not less than 2000 pages, and which will be ready in Spring.

The Siemens & Halske Co. and the **Siemens-Schuckert Co.** of Germany, have opened American offices, with headquarters

at room 1559, Hudson Terminal Building, New York City, in charge of Dr. Carl G. Frank. Among the apparatus which they intend to push especially in this country are the well-known Siemens ozone apparatus for purification of water, further high-grade laboratory and switchboard instruments, Roentgen apparatus, induction coils, etc.

Grab Buckets and Tubs.—The Brown Hoisting Machinery Co., of Cleveland, have sent us their new bucket catalog. "Brownhoist" grab buckets, varying from 10 tons to ½ ton in capacity, are used the world over for handling coal, ore, limestone, clay, cinders, sulphur, etc. The well-known two-rope buckets are illustrated in use on many different types of machines. The single-rope buckets for use on existing machines, having but a single-drum engine, are also described and illustrated. Automatic dumping tubs for handling coal, ore, stone, etc., are also described. The catalog is illustrated by many very fine and interesting illustrations.

Storage Batteries.—We have received from the Haschke Storage Battery Co., of 271 Michigan Avenue, Chicago, their catalog of the Haschke "fool-proof" storage battery. The plates are of thin cast lead, electrochemically formed. Each positive plate is encased in an envelope that perfectly insulates it. This insulating envelope, which is sufficiently porous to permit free circulation of the electrolyte and which is practically indestructible, is the main feature of the battery. The plates are "of such thickness as to withstand the strain of peroxidizing and at the same time to obviate the danger of buckling, while thin enough to materially reduce the weight of the cell, thereby making an accumulator capable of standing heavy charging and discharging without injury, and of quickly reviving itself." The battery is chiefly intended for ignition purposes, electric automobiles and yachts, for car lighting and for laboratory work.

Fused-Quartz Chemical Apparatus.—The Wilson-Maenlen Co., 1 East Forty-second Street, New York, have issued a very artistic catalog of quartz chemical apparatus. It may not be generally known that there are two kinds of fused quartz on the market, one transparent and the other only translucent. The transparent quartz is made from rock crystal SiO_2, for laboratory sizes only; all surfaces are perfectly glassy (indeed, a transparent quartz tube has exactly the appearance of a glass tube); complex forms, such as retorts and distilling flasks, are made very symmetrical; transparent-quartz apparatus are quite expensive. Translucent-quartz apparatus are much cheaper; they are also made from pure silica in large and small apparatus; in laboratory sizes both surfaces are smooth, large pieces have one smooth and one frosted side. The translucent quartz is sold in this country under the trade name "electroquartz." Both the transparent quartz and the electroquartz are not attacked by acids (except hydrofluoric), have a melting point above 2900° Fahr., and such a small coefficient of expansion as to stand the most violent and sudden changes of temperature without cracking. Quartz has high electric insulating properties, even at high temperatures. Fused quartz apparatus may be used as a substitute for platinum and fine porcelain for many purposes in the laboratory and chemical factory.

Acetone.—According to the Cleveland *Leader*, Mr. K. P. McElroy, of Washington, D. C., has brought suit against the Kessler Co. and Mr. W. A. Harshaw, of Cleveland, for infringement of the patent for making acetone of Mr. H. O. Chute, consulting chemical engineer, of New York City.

Steel Rails from Cuban Iron Ore.—The Bethlehem Steel Co. is reported to make now steel rails containing 0.75 carbon and below 0.04 phosphorus and sulphur in their open-hearth furnaces, using pig iron from very pure iron ore of Cuban mines. These rails are said to be sold at quite an advanced price.

Repairing Iron and Steel.—A compound placed on the market by the H. W. Johns-Manville Co., of New York, under the name of "Leak-No," resembles powdered iron and when mixed with water and applied like putty to defects in iron or steel articles, the manufacturers claim that it metallizes and becomes a permanent part of the article to which it is applied. In color it very much resembles iron, when hard. It is stated to be applicable to mend cracks in oil, steam, gas, air, ammonia or water pipes and to stand pressure as well as heat.

Pyrometer Testing.—An excellent little pamphlet of 11 pages, which should be in the hands of all chemical and metallurgical engineers, has just been issued by the Bureau of Standards of Washington on pyrometer testing and heat measurements. It is Bureau Circular No. 7. It contains the regulations on pyrometer tests of the Bureau and a table of the fees charged by the Bureau for the tests. The pamphlet is, however, generally valuable for its concise statement of the chief points which must be remembered in the calibration and use of the various types of pyrometers.

Nickel Salts for Nickel Platers.—Messrs. Fuerst Bros. & Co., 2 and 4 Stone Street, New York, have sent us the following interesting analyses of English nickel salts, made by the Mond Nickel Co., Ltd., of which Fuerst Bros. & Co. are the American representatives. According to analyses of Messrs. Stillwell & Gladding their pure commercial double salt, nickel ammonium sulphate contains 15 per cent nickel, no arsenic, no insoluble matter, and only a trace of iron, while the single salt, nickel sulphate, contains 21.05 per cent nickel, no arsenic, and traces only of iron and insoluble matter. These salts are therefore of excellent quality for nickel plating purposes.

The Jewell Water Improvement Co., of 120 West Jackson Boulevard, Chicago, has just issued its exceedingly well-illustrated catalog No. 8 describing its water purification apparatus for all classes of work, from the smallest capacity for family use to types used in filtering water for the largest cities. Illustrations, with descriptive notes, are given of the various gas-operated and steam-operated Jewell stills, also of Jewell stone filters, pressure filters, gravity filters, and settling tanks. The largest filter plant in the world of the American system, with a capacity of 100,000,000 gallons per day, for the purification of the Ohio River water at Cincinnati, Ohio, is built and operated under the patents of Ira H. Jewell.

Thermit in the Foundry.—The Goldschmidt Thermit Co. has just issued an illustrated pamphlet, full of valuable information, on applications of thermit in foundry practice. The chief value of thermit in foundry works consists in the fact that the high reaction temperature of thermit (5400 deg. F.) can be produced anywhere and without apparatus of any kind, to increase the temperature of iron and steel and facilitate the introduction of other refractory metals which it may be desired to alloy with the metal for special purposes. It provides the only means of poling metal in the ladle without reducing its temperature. Thermit is not used in the converter or cupola, but only after the metal is in the ladle, ingot or riser. The various applications of thermit for these purposes are then described. Then follows an illustrated report of Engineer A. Obholzer on the methods used to avoid piping in steel ingots as applied in the Hungarian Government steel foundries at Diosgyor. The pamphlet is concluded by short articles on nickel thermit as an addition to cast iron and on calcium silicide as a purifier for metals, particularly steel.

Chemical Industries of Germany.—According to a recent consular report the German Society for the Protection of the Interests of the Chemical Industry at its recent annual meeting reported that no serious effects had thus far resulted from the general business depression. The number of chemical factories in Germany increased from 8505 at the beginning of 1907 to 8618 at the end of the year. The number of employees increased from 195,000 to 207,000. Their wages advanced from $49,266,000 to $54,740,000. The stock companies, numbering 166, reported at the close of 1907 a total stock capital of $125,806,800, reserves of $41,316,800, and outstanding debts amounting to $22,514,800. They paid in dividends the sum of $19,444,600 on the entire capital. This is an increase of 0.38 on the rate for 1906. The profits vary greatly in

the different branches. The average rate of profit during 1907 for the entire industry was 10.73 per cent, an advance of 0.7 per cent over the rate for 1906. The outlook for a continuance of high profits is not considered as favorable, partly on account of recent tariff arrangements and partly on account of the requirements of the new British patent law. But the customs statistics of the German Empire for the first half of 1908 give a most satisfactory showing for the commerce in chemicals. In comparison with the same period of 1907, there is a slight lessening of imports and a more marked increase in exports. The total exports of chemicals in the first six months of 1908 were 1,170,714 metric tons (against 1,143,376 in 1907) and the total imports 792,776 tons (against 800,423 in 1907).

Electric Laboratory Apparatus.—We have received from Mr. C. H. Thordarson, 153 S. Jefferson Street, Chicago, his catalog No. 3, describing various electrical apparatus for demonstration purposes and for laboratory work. Among them are electromagnets, laboratory transformers, high-tension transformers, a rotary converter for laboratory use, an alternating-current regulator, Ruhmkorff spark coils, and X-ray coils. These apparatus are all specially designed to cover a wide range of experiments. Thus by operating a transformer in series with an alternating-current regulator, all static and high-potential experiments may be shown, including the operation of X-ray tubes and the production of ozone by the silent discharge. Some of the apparatus and appliances may be used for specially striking experiments. For instance, a ring on which an insulated coil is wound carries an incandescent lamp in its center; the system is so designed as to have a specific gravity slightly greater than water. If inserted in a water basin, it will, therefore, sink to the bottom. But when an alternating-current electromagnet coil is placed below the basin, alternating currents are induced in the coil in the water and manifest themselves in a double manner by lighting the lamp and by raising the coil so as to float on the water, due to magnetic repulsion.

Personal.

Mr. **James Gayley,** the distinguished inventor of the dry-blast process, has resigned as first vice-president of the United States Steel Corporation.

Prof. **Joseph W. Richards,** of Lehigh University, secretary of the American Electrochemical Society, after having arranged and attended the New York meeting of the society, sailed again for Europe and intends to visit Switzerland, Italy and Egypt. Dr. Richards will be back in this country by Feb. 1.

Mr. **Albert Ladd Colby,** consulting engineer, of New York City, has returned with his family from Europe, after over a year's absence, studying by-product coke ovens and recovery processes and testing American coal in different types of by-product ovens. Until he opens a new office in New York, his address will be care of Engineers' Club, New York City, or South Bethlehem, Pa.

Digest of U. S. Patents.

Compiled by Byrnes & Townsend, Patent Lawyers, National Union Building, Washington, D. C.

ELECTRIC FURNACES (*Continued*).

575,826, Jan. 26, 1897, J. A. Deuther, of Boston, Mass.

Arc type. Feed charge-mixture, e. g., lime and carbon, directly into a shifting arc. The lower electrode is a cylindrical block, set vertically in the brick bottom of the shallow-pot furnace. The upper electrode is a cylindrical pencil of somewhat smaller diameter, hung so as to vibrate as a pendulum, being pivotted on a vertically-adjustable support. One or more charge-feed boxes, having an apertured bottom, are arranged to reciprocate in guide-ways mounted on the upper electrode, being automatically moved as the electrode vibrates. The charges drop into the arc alternately on opposite sides of the upper electrode as it vibrates.

575,829, Jan. 26, 1897, John Joyce, of Andover, and James A. Deuther, of Boston, Mass.

Arc type. Feeds the charge mixture, e. g., lime and carbon, directly into a shifting electric arc. The lower electrode is a vertical cylindrical block, arranged on a reciprocating truck. The upper electrode is a fixed cylindrical pencil of somewhat smaller diameter. The electrodes are surrounded by a low inclosing wall, the furnace chamber being open at the top. Two feed boxes with open bottoms are arranged to reciprocate in a guide-way mounted on top of the upper electrode. Mechanism is provided for reciprocating the lower electrode and for simultaneously shifting the feed boxes so as to deliver the charge alternately at opposite ends of the upper electrode and onto the upper end of the lower electrode.

577,317, Feb. 16, 1897, Francis Jarvis Patten, of New York, N. Y.

Resistance type. A plurality of vertical carbon-rod resistors are arranged in a circle within a circular furnace wall. The upper end of each resistor is connected through a switch to the positive terminal of a direct-current dynamo. The lower ends of all of the rods are embedded in the carbon floor of the furnace, which is connected to the other terminal of the dynamo. The space within the furnace chamber and around the rods is filled with a charge-mixture, e. g., for the production of calcium carbide. A large carbon pencil occupies the dead or relatively cool space at the center of the charge, its lower end being imbedded in the carbon furnace floor. A current of, say, 300 amp at 50 to 100 volts is passed by the switch successively through the several resistors, quickly bringing each to incandescence. The switch comprises a circular tub containing acidulated water, with carbon plates, respectively connected to the resistors, arranged on its inner wall. A centrally pivotted carbon slab, connected to the dynamo, rotates in opposition to the plates.

577,329, Feb. 16, 1897, Nicholas Slawianoff, of St. Petersburg, Russia.

Arc type. Melts and casts metal in the form of rods, e. g., iron or steel, pig iron or copper alloys. The rod forms one electrode of a self-regulating arc, the end of the rod continuously melting off and moderating the temperature of the arc. The mold to receive the molten metal may constitute the other electrode. If the mold is non-conducting, it may contain a carbon or metal electrode to start the arc, the melted metal in the mold thereafter acting as electrode. For casting pig iron, the electrode which is melted should be positive; if negative, the cast iron is hard and useless. The molds for pig iron and copper alloys consist of compressed coke; those for iron and steel of quartz sand and a binder. According to a modification, two rods may be simultaneously melted, each being carried by a magnetic regulator and arcing to the pool of metal. Or one of the rods may be submerged in the pool, the other arcing to it. When large rods are melted, small pieces of metal may be melted by throwing them into the pool. The process is useful for uniting two pieces of metal by casting molten metal into the space between them. Also for filling blowholes in pig iron and copper, cracks and sand-blows in steel articles, and vents in iron pieces. The process may be rendered continuous by screwing additional lengths onto the rod to be melted. To soften the melted cast iron an arc may be sprung from a carbon-rod anode to the molten iron, impregnating it with graphite. Or the molten iron and steel may be run through a carbon tube into a coke mold. Hard, white pig iron may be superficially softened by melting and carburizing its surface by the arc from a carbon anode.

577,370, Feb. 16, 1897, Francis Jarvis Patten, of New York, N. Y.

Arc type. Employs arcs which reciprocate laterally between the lower end of a vertical carbon plate and the upper surface of a horizontal carbon plate. Shows two furnaces. The first

has an inclined carbon bottom, above and perpendicular to which are several parallel carbon plates. The plates are connected to one terminal of an alternating-current dynamo; the hearth to the other terminal. An electromagnet is arranged to produce a magnetic field within the arcing region. As the current slowly alternates, the arcs travel back and forth along the lower ends of the plates. The second and preferred type of furnace is similar, except that the upper plate electrodes are connected to the positive terminal of a direct-current dynamo and the lower electrode to its negative terminal. The magnetic field is slowly reversed to reciprocate the arcs by a commutator containing a liquid and connected to the dynamo by a shunt circuit.

NEW BOOKS.

Untechnical Addresses on Technical Subjects. By Ja. Douglas. 169 pages. Bound in cloth. Price, $1. New York: John Wiley & Sons.

Electric Furnaces: The Production of Heat from Electrical Energy, and the Construction of Electric Furnaces. By Wilhelm Borchers. Translated by H. G. Solomon. 233 pages. Bound in cloth. Price, $2.50 net. New York: Longmans, Green & Co.

Practical Metallurgy: An Introductory Course for General Students. By B. T. Turner. 103 pages; illustrated. Price, $1.25 net. Philadelphia: Lippincott.

Mineral Resources of Alaska. By Alfred H. Brooks and others. 299 pages. Office of Superintendent of Documents. Washington, D. C. (Department of the Interior, United States Geolog. Survey bull.).

A College Text-Book of Chemistry. By Ira Remsen. 725 pages; illustrated. Price increased from $2 to $2.25. New York: Henry Holt & Co.

A Text-Book of Experimental Chemistry (With Descriptive Notes) for Students of General Inorganic Chemistry. By Edwin Lee. 470 pages; 57 illustrations. Bound in cloth. Price, $1.50. Philadelphia: P. Blakiston's Son & Co.

The Refrigerating Engineer's Pocket Manual. By Oswald Gueth. 160 pages. Bound in cloth. Price, $1.50. New York: Oswald Gueth.

Gas and Fuel Analysis for Engineers: A Compend for Those Interested in the Economical Application of Fuel. By Hermann A. Gill. Fifth edition, revised. 124 pages. Bound in cloth. Price, $1.25. New York: John Wiley & Sons.

Cement Laboratory Manual: A Manual of Instructions for the Use of Students in Cement Laboratory Practice. By L. A. Waterbury. 129 pages; figures. Bound in cloth. Price, $1.

Hydraulc Tables and Memoranda. By Herman Daniel Jerrett. 150 pages; diagrams. Bound in cloth. Price, $1.50. San Francisco: Hicks-Judd Co.

Steam Power-Plant Engineering. By G. F. Gerhardt. 945 pages; figures. Bound in cloth. Price, $6 net. New York: John Wiley & Sons.

The Mechanical Engineering of Steam Power Plants. By Frederic Remsen Hutton. (Third edition, rewritten.) 166 pages. Bound in cloth. Price, $5. New York: John Wiley & Sons.

Dynam-Electric Machinery. By Francis Bacon Crocker. 238 pages. Bound in cloth. Price, $1.50. Chicago: American School of Correspondence.

Storage Batteries, Their Theory, Construction and Use. By Arthur Eugene Watson. 153 pages; illustrated; diagrams. Bound in cloth. Price, $1.50. Lynn, Mass.: Bubier Publishing Co.

Lecture-Notes on the Theory of Electrical Measurements. By W. Arnold Anthony. 131 pages; figures. Bound in cloth. Price, $1. New York: John Wiley & Sons.

The Strength of Concrete Beams. By R. S. Humphrey. 59 pages. Office of Superintendent of Documents, Washington, D. C. (Dept. of the Interior, United States Geolog. Survey bull.).

Pipes and Tubes. By Philip R. Bjorling. 244 pages; 191 illustrations. Bound in cloth. Price, $1.25. New York: Macmillan Co.

Physics for Secondary Schools. By C. F. Adams. 490 pages; illustrations, diagrams. Bound in cloth. Price, $1.20. New York City: American Book Co.

Progressive Problems in Physics. By Fred. R. Miller. 244 pages; tables. Bound in cloth. Price, 60 cents. Boston: Heath.

Notes on Thermodynamics. By Wilson H. Spangler. (The derivation of the fundamental principles of thermodynamics and their application to numerical problems.) 82 pages. Bound in cloth. Price, $1. New York: John Wiley & Sons.

An Elementary Treatise on the Differential Calculus. By W. Woolsey Johnson. 201 pages; figures. Bound in cloth. Price, $1.50. New York: John Wiley & Sons.

The Niagara River. By Archer Butler Hulbert. 332 pages, with maps and illustrations. Bound in cloth. Price, $3.50 net, boxed. New York: Putnam.

BOOK REVIEW.

Introduction to Metallography. By Dr. Paul Goerens, docent in physical metallurgy at the Institute of Technology of Aachen. Translated by Fred. Ibbotson, lecturer in metallurgy at the University, Sheffield. 214 pages, 158 illustrations. Price, $2.50. New York: Longmans, Green & Co.

The original German edition appeared in 1896. We quote from the author's preface: "This little book proposes to introduce the learner to the somewhat unfamiliar phenomena of physical chemistry, so far as they need consideration for metallographical purposes, and to make it possible for him to obtain a glimpse of the methods of investigating metals and alloys." Since it is the only book of its kind and since it is a good book, especially for steel metallurgists, the translation into English is heartily to be recommended.

After a description of the methods of determining cooling curves in the first chapter, the second deals with "the physical mixture" (aqueous solutions, fused salts, alloys) and applications of the phase rule. Then follows a chapter on "practical microscopy of metals," with useful hints on the preparation of the section by grinding and polishing, development of the structure by etching, and directions for the use of the microscope and camera. (With respect to grinding, it is peculiar that carborundum does not seem to be known yet in Europe as a commercial article.)

The last chapter, and the most important of the book, deals with the special metallography of iron and its alloys. This chapter has been practically rewritten for the English edition and thus brought up to date by the author.

In the whole, the book is only an introductory treatise, but as such, we wish to repeat, it is good and valuable.

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Modern Practice in Mining, Vol. 1, Coal. By Prof. R. A. S. Redmayne. Price, $2. New York: Longmans, Green & Co.

This is an admirable book. It is short and concise; yet it covers fairly thoroughly the occurrence of coal, the testing of its values, and the prospecting for it by means of modern drilling apparatus, such as the diamond drill.

Though written by an Englishman, we believe it will be useful to the American coal engineer, for it is a practical and well-written book. The author evidently knows his business.

No information is given on the ways and means of mining coal and getting it out, but it is to be presumed that this will be given in another volume.